NO. 51 AUGUST 1982

U.S./Canada Edition: $2.50
International Edition: $2.95
United Kingdom Edition: £1.80

MICRO™

THE 6502/6809 JOURNAL

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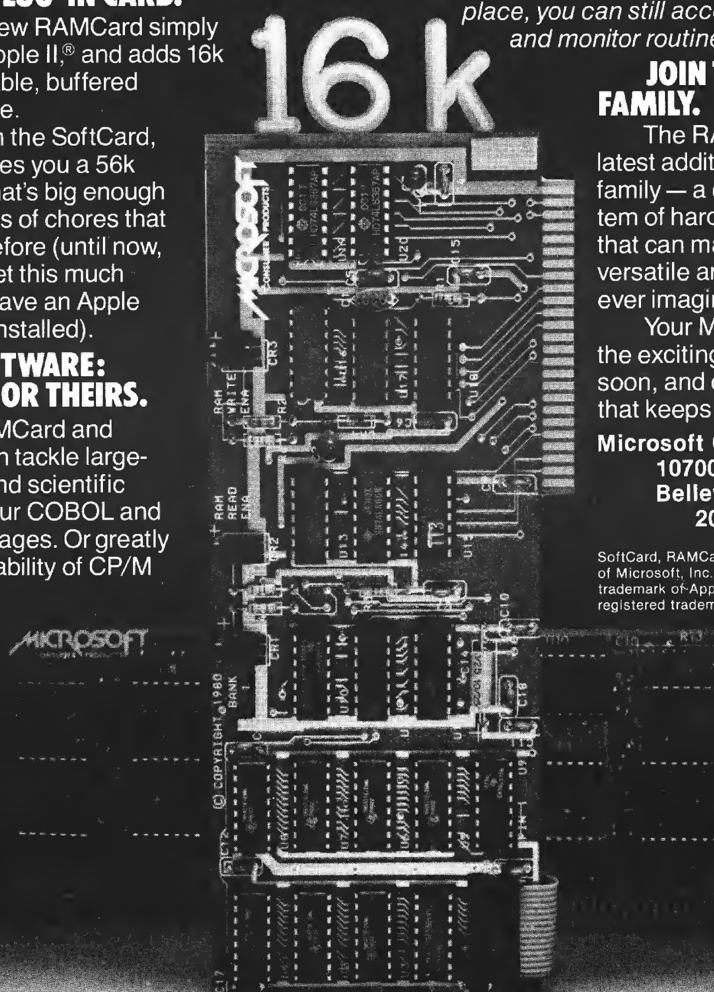

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THE 6502/6809 JOURNAL

PROGRAMMING TECHNIQUES

I/O ENHANCEMENTS

BASIC AIDS

DEPARTMENTS

About the Cover

```
0914 290F          AND #F
0916 F0F7          BEQ NEW4        ; COLOR SHOULD NOT BE BLACK
0918 8505          STA REM         ; LET UPPER NIBBLE OF COLOR-
091A 0A            ASL             ; MASK EQUAL LOWER NIBBLE
091B 0A            ASL
091C 0A            ASL
091D 0A            ASL
091E 0505          ORA REM
0920 911E          STA (TINT),Y
0922 60            RTS
0923          ;
0923          ; * * *  RANDOM NUMBER GENERATOR  * * *
0923          ;
0923          ; IDENTICAL TO LISTING 1
0923          ;
0930               ORG $930
0930 18       RND  CLC
0931 A203          LDX #3
0933 B510          LDA $10,X
0935 CA            DEX
0936 7510     LOOP1 ADC $10,X
0938 9510          STA $10,X
093A CA            DEX
093B 10F9          BPL LOOP1
093D A203          LDX #3
093F F610     LOOP2 INC $10,X
0941 D003          BNE RTS1
0943 CA            DEX
0944 10F9          BPL LOOP2
0946 60       RTS1 RTS
                   END
```

The penguins on this month's cover happily reside in one of the country's larger, and more modern zoos. Computers help keep these penguins — and their fellow zoo-mates — content by monitoring care and feeding procedures and storing information on the animals' environmental needs.

Cover photo: Jack Smith
Groton, Massachusetts

MICRO is published monthly by:
MICRO INK, Chelmsford, MA 01824
Second Class postage paid at:
Chelmsford, MA 01824 and additional mailing offices
USPS Publication Number: 483470
ISSN: 0271-9002

Send subscriptions, change of address, USPS Form 3579, requests for back issues and all other fulfillment questions to
MICRO INK
34 Chelmsford Street
P.O. Box 6502
Chelmsford, MA 01824
or call
617/256-5515
Telex: 955329 TLX SRVC
800-227-1617

Subscription Rates	*Per Year*
U.S.	$24.00
	2 yr. / $42.00
Foreign surface mail	$27.00
Air mail:	
Europe	$42.00
Mexico, Central America, Middle East, North Africa, Central Africa	$48.00
South America, South Africa, Far East, Australasia, New Zealand	$72.00

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Editorial

Higher than High-Level?

The Observation Level of Boston's John Hancock Tower was an appropriately lofty setting for the unveiling of Software Arts' latest product, TK!Solver (the "TK" stands for "Tool Kit"). The developers of VisiCalc have produced TK!Solver to settle the question, "Can they do it again?" As the lights dimmed, and company president Dan Bricklin sat down at the keyboard of an IBM Personal Computer, everyone knew that VisiCalc was going to be a tough act to follow.

Why have the creators of VisiCalc waited so long to launch a new product? Vice President Tracy Licklider explained that Software Arts has been developing "revolutionary" translation techniques. Using them, Software Arts can adapt a program to a new machine in a matter of days. The process transports an exact replica of a program into a new environment, neither introducing new bugs nor removing old ones. A user can therefore invest time in learning how to use a Software Arts product without worrying about whether those skills will be transportable. If a computer has a significant market share, Software Arts plans to make a compatible program version available.

When Dan Bricklin's large demonstration screen lit up, we saw a format suggestive of VisiCalc, but not organized according to rows and columns. TK!Solver allows the user to specify relationships between defined variables, give the computer data, and have it relate the data to the equations and print an answer. For example, in calculations dealing with real estate mortgages, the user would give the computer an equation that defines the relationship between principal, interest rate, monthly payment, and term of the loan. Given any three of the known values, TK!Solver can quickly calculate the unknown value. The program establishes on its own a sequence of problem-solving steps.

The grey eminence behind TK!Solver, Professor Milos Konopasek of North Carolina State University at Raleigh, has spent more than 10 years developing the artificial intelligence techniques used in the TK!Solver program. These techniques, Konopasek says, enable people to interact with computers at a higher level than they can with "high-level" languages like BASIC and Pascal. While such languages relieve the user of having to give the microprocessor any instructions, they impose a sequential method of problem-solving that is not natural to the human mind. Professor Konopasek calls TK!Solver a "non-procedural programming language," in which the user can conceptualize a problem as a network of defined relationships instead of a rigid sequence of procedures. The result is a more natural, higher-than-high-level, problem-solving computer environment.

Software Arts plans to market TK!Solver in the fourth quarter of 1982, for $299.00. It will first be available on the IBM Personal Computer and the Apple II. In addition to the TK!Solver program itself, Software Arts will produce a series of special application packages for use with the program. These will be available initially in the areas of mechanical engineering, financial analysis, high school science, and architectural design and construction. Each package will include the equations, tables, and values commonly used to solve typical problems in a given area.

MICRO supports the efforts Software Arts is making to bridge the compatibility gap between computers. The TK!Solver program, in combination with the application packages, may make it possible for non-specialists to tackle problems only a degreed professional could previously handle. If so, the computer revolution could be on the verge of realizing some of its enormous potential.

Laurence Kepple

MICRO™

News

Steve Wozniak Creates Cultural Fall Festival

Three of the major cultural forces of the 80's — technology, music, and education — will meet in San Bernardino County over Labor Day weekend for an event called the "Us Festival." Steve Wozniak, co-founder and inventor of Apple Computer, predicts that the "Us Festival will be one of the most significant Labor Day weekend celebrations in the history of America." Wozniak has planned the festival to signal a shift from the "me decade" of the 70's to what he calls an "us decade" for the 80's. Festival promoters have signed top entertainers and expect to draw more than 300,000 people to the three-day event.

According to Wozniak, widespread popular understanding and acceptance of computers will be an important factor in helping us all work together to solve our problems. "The value of people combining their efforts in families, the work force, and society can't be overemphasized," Wozniak said. "My hope is that the Us Festival will underscore the importance of those individual efforts and the role that computers can play in making interaction and cooperation both more effective and more fun."

A Technology Fair will feature exhibits of exciting new applications of computer technology as it relates to communications, education, small business, music, and ecology. For those unable to attend, a specially created Us Network will telecast the event live to theaters and millions of homes throughout America. No tickets may be purchased at the door. Contact The Us Festival at P.O. Box 95108-1157, San Jose, CA 95108, or at #TCW 314 on The Source.

NewsNet: Newsletters for the Business Community

Up to 130 newsletters from 30 publishers are now available to the business community through NewsNet, an electronic information distribution and retrieval service.

Newsletters offered include *Communications Daily, Television Digest, Telecommunications Reports, Data Channels, Cablenews, Energy Daily, Coal Outlook, IRS Practices and Procedures, Education Funding News, Federal Grants and Contracts,* and *Hazardous Waste News.*

According to NewsNet president John H. Buhsmer, many areas of industry will be represented, including farming and food, environment, investment, health, and general business.

Write to NewsNet at 945 Haverford Rd., Bryn Mawr, PA 19010.

Low Cost Electronic Mail System

Small businessmen and computer hobbyists unable to afford expensive electronic mail accounts, can now enjoy this service by joining DCI.DEAFNET. Although primarily a nationwide electronic mail system for the deaf, DCI.DEAFNET now offers their service at considerably lower cost than other electronic mail accounts.

According to DCI.DEAFNET business manager Mary Robinson, anyone wishing to connect to the system pays a small monthly fee and a straight connect charge.

DCI.DEAFNET is offered by the Deaf Communications Institute. For more information contact Ms. Robinson at 95 Bethany Rd., Framingham, MA 01701, (617) 875-3617.

THE SOURCE Increases Services

THE SOURCE has added two features to its services: MAILGRAM messages and a WATS system.

MAILGRAM messages composed by SOURCE subscribers may be sent from their computer to anywhere in the United States. If the messages are entered by 4 p.m., EST, they are virtually guaranteed next business day delivery.

Western Union's largest MAILGRAM processing center receives the SOURCE messages, then routes them by zip code to the appropriate post office. There they are printed and delivered.

SOURCE subscribers can access this service by signing on, then typing MGRAM. Further instructions prompt them through the necessary steps to complete the message.

Messages up to 100 words cost $5.15; each additional 100 words cost an extra $1.00. Discounted prices for identical text are available.

The new SOURCE WATS system enables subscribers to dial direct to SOURCE computers at a reduced cost. For a .25 cent surcharge, along with the standard usage fee, subscribers can dial a specified 800 number and be connected with their host computer.

If you have any questions on these, or any other SOURCE services, write to Source Telecomputing Corp., 1616 Anderson Rd., McLean, VA 22102, (703) 734-7500.

Stock Market Information for Micro Users

Investors with personal computers now have free access to a computerized stock market bulletin board service, called Tickerscreen. Information provided on Tickerscreen includes closing New York Stock Exchange prices, closing market indexes, commission computation on any stock or option transaction, and a demonstration of Tickertec, the personal stock market monitor.

Tickerscreen is available from 5:00 p.m. to 9:00 a.m. weekdays, and 24 hours on weekends. To enter the system, dial (212) 986-1660, and connect your computer to your phone. For more information contact Max Ule and Co., 6 E. 43rd St., 27th Fl., New York, NY 10017, (212) 687-0705.

Electronic Newspaper for Texas TRS-80 Owners

Radio Shack and the Fort Worth Star-Telegram now offer STAR-Text, an electronic newspaper home information service for the local Fort Worth, Texas, area.

STAR-Text will provide subscribers with hard news, entertainment information, and shopping information. Hard news includes local, state, national, and international stories, sports, and weather. Subscribers will have access to movie reviews, concert listings, and live theater and ticket agencies. To help with shopping, STAR-Text will offer consumer advice information, classified advertising, and product information.

For more information, contact the Star-Telegram at (817) 390-7455.

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6502 vs. 6809 Questions

Dear Editor:

I would like to discuss the article by Gregory Walker and Tom Whiteside, "Multiprecision Addition — A Comparison of 6809 and 6502 Programming" (MICRO 47:57). In their first example (figure 1), the time for 12 zero-page instructions for the 6502 was given as four cycles each instead of three. The corrected subroutine time should be 51 cycles for the 6502 as opposed to 50 for the 6809.

In their second example, "the restriction that these subroutines must leave all processor registers unchanged" (except flags), was not adhered to for the 6809's index registers. If we eliminate the same restriction for the 6502's index registers and correct the branch-not-taken timing, the total time becomes 100 cycles as opposed to 101 for the 6809. The correct byte count for the 6502 is 16 as opposed to 17 for the 6809.

If the 6809 has any clear advantage over the 6502 in terms of execution time or memory usage, it certainly can't be proved by these examples.

George Wells
1620 Victoria Place
La Verne, CA 91750

Mr. Wells is correct that the 6502 LDA and STA instructions in figure 1 use three cycles instead of four cycles. Thanks for pointing out our goof! Including the setup time, the 6502 needs 75 cycles versus 70 for the MC6809.

His comment that we did not preserve the index registers in the second example is not true. *The only registers changed were the "A" and "B", which were saved with the PSHS D instruction. He is correct that we missed the "1" cycle for the 6502 branch-not-taken. If we include the setup time, the 6502 needs 111 + 36 = 147 cycles* versus *101 + 24 = 125 cycles for the MC6809. The MC6809 program is faster despite the added overhead for using position-independent code (a penalty we did not require of the 6502).*

The MC6809 was more byte efficient and faster than the 6502 examples, but we trust that perceptive readers will not limit the comparison to these factors. Consider also that the MC6809 offers extra registers, many of which are 16-bit indexes. It offers the ease of writing position-independent code, extra addressing modes and extra instructions, a reduced dependence on "zero page" RAM, and a stack that may range anywhere in memory.

Greg Walker and Tom Whiteside

COPCOP Updated for OS65D 3.3

Charles H. Ellis, Jr., of Lynn, MA, sent in this update:

Peter Kleijnan's disk copy program ("COPCOP Single Drive Copier," MICRO 47:21) is a brilliant example of OSI C4P programming. After three years of compulsively programming my C4P, I thought that I had explored every corner of the operating system. What a pleasant surprise to find that a DOS command file can be executed

***Listing 1:* Corrections to run on OS65D 3.3.**

```
5 POKE 133,79
110 DIMD$(39,8):CR$=CHR$(13):MA=INT( (PEEK(8960)
    -36)/8)
998 DATA 2,10,18,26,64,72,88,96,104,112,120,128,136,144
1080 DISK!"ME F000,5000":PRINT#5,"EXIT";CR$;:PRINT#9
1164 PRINT#5,"CA 0200=06,4";CR$;CR$;"Insert
     MASTER disk";CR$;
1280 DISK!"ME 5000,F000":DISK!"IO 10,02":RETURN
```

***Listing 2:* Directory Cleanup Modifications**

```
90 DB=11897:DEFFNA(X)=10*INT(X/16)+X-16
   *INT(X/16)
1091 PRINT:INPUT"Directory Cleanup";DC$
1093 IF DC$="Y"THEN DISK!"CA 2E79=12,1"
2010 IF D$(I,1)=" "ORD$(I,1)="N"THENGOSUB8000:
     I=I+1:GOTO2005
5035 IF DC$="Y"ANDJ=12THEND$(12,1)="2E79/1"
8000 TT=I:IF DC$ < > "Y"THEN8090 : REM — Directory
     Entry Delete
8010 FOR II=DB+6 TO DB+254 STEP 8
8020 IF TT < FNA(PEEK(II)) OR TT > FNA(PEEK(II+1))
     THEN 8060
8040 FOR JJ=II-1 TO II-6 STEP-1:POKEJJ,ASC("#"):
     NEXTJJ
8050 POKE II,0:POKE II+1,0
8060 NEXT II
8090 RETURN
```

Letters/Updates *(continued)*

directly from memory (another example of the power of OSI's system architecture).

I wish to offer some corrections to this excellent program so that it will run on the new OS65D 3.3, and present a directory clean-up subroutine to enhance the disk copier.

Corrections

Under the new V3.3 of OS65D, "COPCOP" will not run without the revisions shown in listing 1. Since V3.3 BASIC and the keyboard enhancement occupy 2K of memory not used in OS65D 3.2, the published program produces an 'OM' error when it tries to dimension the 39 × 8 array. Also, the track 0 copy utility has been relocated on the V3.3 system disk from track 13 to track 6.

These problems are simple to solve. Moving up the top of the BASIC workspace by 2K leaves ample room for the array. Changing the address in lines 1080 and 1280 from $4800 to $5000 moves the memory output and input, and replacing 80 with 72 in the DATA statement (line 998) protects the command file block during copying. Changing the call in line 1164 from 13,1 to 06,4 correctly locates the track 0 utility.

The added 2K of DOS permits copying of one less track in each pass, and requires the change in line 110 (from PEEK(8960) – 29 to PEEK(8960) – 36). This still allows copying of 19 tracks per pass on a 48K machine, and 7 tracks on my 24K system.

Update —
Directory Cleanup Subroutine

I have always been frustrated that most disk copiers simply copy the original disk directory to the copy disk, even when some tracks have not been copied to the new disk. COPCOP inspired me finally to deal with this problem. If the new lines of listing 2 are added to the program, the new disk can, optionally, be provided with a directory which includes only those files which were fully copied.

When a track is not to be copied, or has a missing header, the subroutine searches the directory buffer ($2E79-$2F78) for an entry including that track number. If the search succeeds, the buffer is edited to delete the entry. If this option has been selected, the edited directory buffer will be saved to disk during copying, rather than a copy of the original track 12,1.

A warning: this routine works only for a directory complete in the first page of track 12. I have never yet had a disk with more than one page needed for its directory. Only on a data disk might you have more than 32 one-track, named files. If this large a directory exists, the disk should be copied without the cleanup option. Then the directory can be cleaned up in the old way, by hand, file-by-file, using a delete program. I don't expect to have to do this.

MICRO

Data Transfer from AIM to PET

by Alan K. Christensen

Software is provided to transfer data, such as machine-language programs, from the AIM to the PET.

AIM to PET
requires:

PET
AIM 65 or SYM
AIM Assembler ROM
Cable (see page 12)

The owner of any popular computer soon realizes that it is easy to get locked into using only the programs and peripherals offered by that manufacturer. This article grows from a belief that almost any computer can be expanded by adding a different computer in a network. This allows the user to choose between peripherals, tape formats, and programs offered for either machine. This article explains how to make a logical connection between a Commodore PET and a Rockwell AIM 65.

I purchased my AIM after a lengthy search for a fast PET assembler that would run in my 8K PET. Throughout this search, I kept admiring the small ROM-based editor assemblers found on the SYM and AIM. I decided that if I waited long enough a similar product would be available for the PET. After waiting, and adding up the cost of commercial software and the required memory expansion and additional peripherals, the cost of an AIM no longer seemed too high, so I bought one.

(Editor's note: ASM-TED is a cassette-based assembler written in machine language for the 16K PET and other 6502 computers. It is available for $49.95 from Eastern House Software, 3239 Linda Drive, Winston-Salem, NC. Two small, ROM-based assemblers have recently become available: Mikro from Skyles Electric Works, 231E South Whisman Road, Mountain View, CA 94041, and EZ-ASM from Data Cap, 73 Rue du Village, 4545 Feneur, Belgium.)

The AIM editor and assembler are not the fanciest programs, but they do have features that I required most. The assembler accepts standard 6502 mnemonics with symbolic names. It is not, however, a macro assembler. The editor is line-oriented with search and replace capabilities as well as insert and delete. With the code in ROM, they leave most of the RAM available for text or symbol tables. The combination makes it reasonable to develop serious programs in assembly language. My only problem was to get the programs from the AIM to the PET.

There appeared to be three ways to transfer information between the two computers: manually, through a storage medium, or with a direct connection. The direct connection approach turned out to be the easiest. For details on how to construct a cable, see page

Once the two machines are connected, there are many ways to use them in tandem. For example, I use the PET to buffer large amounts of output and send it to a Commodore printer at its leisure. I also use the AIM keyboard as an input device to the PET (my PET has the old, tiny keyboard). All of these applications work best in assembly language, so the first goal is to transfer assembly-language programs from the AIM to the PET. The AIM monitor supports user-defined devices. Listing 1 shows a simple software interface to get the assembly object out of the machine by sending it to the user (U) device. There is more information on the data transfer in the AIM manuals.

The interface as described supports only half-duplex transmissions. This means that the PET has to be ready to accept the information when the AIM sends it. The program for the PET is written in BASIC because it is easier to enter and debug a BASIC program on the machine. This program (listing 2) will pick apart the AIM format object code and POKE it into the PET memory. With this program, the parity of the data is not checked, and the PET relies entirely on the checksums in the object format for data integrity.

The program has been optimized for speed. I will briefly describe it from back to front. Lines 800-830 are a trap location and are only entered when an error is detected. The program variables and the 6522 registers are initialized in lines 600-735. This module is written as a subroutine because I occasionally add short, special-purpose routines on the back of the program and they need initialization too. Lines 500-550 process the last line of object format; all other lines are processed in lines 400-480. The bytes are read into an array; if no checksum errors occur, they are POKEd into memory. Subroutine 300-310 returns a 16-bit value based on four hex characters. Subroutine 200-220 returns an 8-bit value based on two hex characters. Subroutine 100-120 gets one character from the interface. The PET user port does not provide a complete A port, so this subroutine has to handshake the values using the CB2 line. The program uses no string variables and will not be affected if another program is loaded into high memory.

By typing GOSUB 600 : GOTO 800 the cable and interface subroutine can be tested. To test the entire routine, dump the contents of $8000-$83FF from the AIM with U as the output device (after assembling the AIM user interface). The PET screen should fill

entirely with various characters, and the PET should not crash. If this operation is successful, the interface has a good chance of being correct.

When the BASIC program is working, the program from listing 3 can be entered into the AIM, assembled, and transferred to the PET. This program is virtually the same as the BASIC program, but written in assembly language. There are two addresses which are valid only for the early versions of the PET. The value of ADDR must be a zero-page location that will not interfere with the operation of the PET. I used $58 at the end of the input buffer in old ROMs. (*Editor's note:* These addresses should work most of the time for upgrade and 4.0 ROMs.) This program places a jump to INIT in memory location 1 and 2 so that the program can be started by typing SYS 0. These locations could be used as the value of ADDR for any PET.

The label CKSTOP is set to the address of a routine which will check to see if the stop key has been pressed and thereby exit the program. This should be changed to the appropriate routine for later ROMs (as indicated in the comments). Any PET can use the get routine address of 65508 for CKSTOP by changing the BEQ EXITI after the label FLAGCK to a BNE EXITI. This will cause the program to halt if any key is pressed on the PET keyboard.

There are additional comments in the listings. The assembler listing has as comments the line numbers that correspond to the BASIC program. These can be used as a guide to the conversion of the program from BASIC. Note that the two programs use different methods to convert hex characters into binary values. To fit the entire assembly-language source into a 4K AIM, it should be entered without comments. The AIM can be expanded to have more memory and additional 6522 ports, so that one AIM could be connected to several PETs.

This program, with some modification, could be used to send object code from an AIM into nearly any 6502-based computer that has I/O lines accessible to the programmer. Once that is accomplished, the way is open for several network programs on the machines. One of the simplest multiprocessing configurations is to have one machine process data while the other controls input or output, including formatting or real-time control. Another possibility: one machine can serve as a memory extension of the other, perhaps maintaining sorted lists or multi-dimensional arrays, and provide data at the command of the master device. In many of these cases, a network approach will provide great improvements in speed and flexibility. The largest pitfall occurs when one machine is running while the other waits, only to have the other machine begin processing while the first waits. As a final caution, if the communications protocol becomes too complex, both machines may spend more time handshaking than working.

Making a Cable

PET		AIM (SYM)		
Pin	**Signal**	**Signal**	**AIM Application Connector Pin**	**SYM AA Connector Pin**
A	ground	ground	1	1
B	CA1	CA2	21	4
C	PA0	PA0	14	D
D	PA1	PA1	4	3
E	PA2	PA2	3	C
F	PA3	PA3	2	12
H	PA4	PA4	5	N
J	PA5	PA5	6	11
K	PA6	PA6	7	M
L	PA7	PA7	8	10
M	CB2	CA1	20	E

Because the PET's CB2 line is used here, other uses, such as sound, will not be possible when transferring data.

Connectors

The connector for the AIM or SYM is a standard 44-pin edge card connector available from Radio Shack and other electronics parts stores. The PET's parallel user port connector may be more difficult to obtain. The following manufacturer's part numbers can be used:

Cinch	251-12-90-160
Sylvania	6AG01-12-1A1-01
Amp	530657-3
Amp	530658-3
Amp	530654-3

SYM VIA Addresses

For the SYM, the following addresses apply for its VIA #2:

Output register A	$A801
Data direction register A	$A803
Peripheral control register	$A80C
Interrupt flag register	$A80D

Alan Christensen received a BSEE from the University of Texas and has programmed both large and small computers for five years. His systems include a PET with a graphics screen display from Micro Technologys Inc., and an AIM with MTU graphics and floppy disks. Mr. Christensen may be contacted at 1303 Suffolk, Austin, Texas 78723.

Listing 1

```
;AIM/PET OUTPUT   OCT 12, 1981      AKC
; THIS PROGRAM CONNECTS THE PET AND AIM
; WITH THE PET BEING DEFINED AS THE
; USER DEVICE OF THE AIM.
;
ENTRY = $2000 ;ENTRY AND LOWEST ADDRESS
;
;
* = $010A ;OUTPUT VECTOR FOR AIM    (SYM - $A663)
UOUT .WORD OUTPUT
;
* = ENTRY
;
OUTPUT = * ;OUTPUT FUNCTION
BCS OUTCHR
LDA #$FF ;OUTPUT STATUS FOR A PORT
STA DDRA
;
;
INITA = * ; 6522 INITIALIZATION
; THIS INITIALIZATION ASSUMES THAT THE A PORT
; HAS NOT BEEN PREVIOUSLY SET TO GENERATE
; INTERRUPTS.
ORAR    = $A001 ;PORT A DATA REGISTER (WITH HANDSHAKE)
DDRA    = $A003 ;PORT A DATA DIRECTION REG
PCR     = $A00C ;PERIPHERAL CONTROL REG
IFR     = $A00D ;INTERRUPT FLAG REG
;
LDA PCR ;SAVE PORT B SETTINGS ON PCR
AND #$F0
ORA #9 ;SET HANDSHAKE FOR PORT A
STA PCR
;
RTS
;
OUTCHR = * ;OUTPUT THE CHARACTER ON STACK
LOOP LDA IFR ;WAIT UNTIL PET IS READY
AND #2 ;THIS ROUTINE WILL HANG THE AIM UNLESS
BEQ  LOOP ;THE PET RESPONDS
;
PLA ;AFTER PET RESPONSE SEND THE CHARACTER
STA ORAR
RTS
;
.END
```

Listing 2

```
10 GOSUB 600 :GOTO 400
100 POKE PCR,P0%:POKE PCR,P1%
105 IF N0 =(PEEK(ITFR) AND CA1) THEN 105
110 A=PEEK(REGA)
115 POKE ITFR,CA1
120 RETURN
200 GOSUB 100:C1=C(A-C0)
205 GOSUB 100:C2=C(A-C0)
210 A=C1*16 + C2
215 KK=KK+A
220 RETURN
300 GOSUB 200:AA=A
305 GOSUB 200:AA=256*AA + A
310 RETURN
400 GOSUB 100:IF A<>SEMI THEN 400
405 KK=N0:NR=NR+N1
410 GOSUB 200:CNT=A
415 IF CNT=N0 THEN 500
420 GOSUB 300 :AD=AA
425 FOR I=N1 TO CNT
430 GOSUB 200 :A(I)=A
435 NEXT
440 CK=KK
445 GOSUB 300
450 IF AA<>CK THEN PRINT"CHECK SUM ERROR":STOP:GOTO 800
455 FOR I=1 TO CNT
460 POKE AD,A(I)
465 AD=AD+N1
470 NEXT
480 GOTO 400
500 GOSUB 300
505 IF AA<>NR THEN PRINT"RECORD COUNT MISMATCH"
    :STOP:GOTO 800
510 CK=KK
520 GOSUB 300
525 IF AA<>CK THEN PRINT"CHECKSUM ERROR":STOP:GOTO 800
530 GOSUB 100
535 GOSUB 100
545 PRINT"DONE":STOP
550 GOTO 800
```

Listing 2 *(Continued)*

```
600 A=0:AA=0:I=0
605 AD=0:REM MEMORY ADDRESS
610 CNT=0:REM BYTE COUNT
615 N0=0:N1=1:REM CONSTANTS
620 CK=0:REM CHECK SUM
625 KK=0:REM BYTE VALUE COUNT
630 C1=0:REM HIGH NIBBLE
635 C2=0:REM LOW  NIBBLE
640 NR=0:REM RECORD COUNT
645 SEMI=ASC(";")
650 C0=ASC("0")
655 PCR=59468:REM PERIFERAL CONTROL REGISTER
660 REGA=59471:REM A DATA (WITHOUT HANDSHAKE)
665 ITFR=59469:REM INTERRUPT FLAG REGISTER
670 CA1=2:REM CA1 INTERRUPT FLAG
675 I=PEEK(PCR) AND (16+8+4+2):REM SYSTEM BITS
680 P0%=I OR ((8+4)*16):REM CB2 LOW
685 P1%=I OR ((8+4+2)*16):REM CB2 HIGH
690 DIM C(15+7):REM CHARACTERS "0"-"F"
695 DIM A(24):REM UP TO 24 BYTES/RECORD
700 DATA 0,1,2,3,4,5,6,7,8,9
705 DATA -1,-1,-1,-1,-1,-1,-1
710 DATA 10,11,12,13,14,15
715 FOR I=0 TO 15+7
720 READ C(I)
725 NEXT
730 POKE 59459,0:REM DATA DIRECTION REGISTER
735 RETURN
800 GOSUB 100
805 PRINT CHR$(A);
810 GOTO 800
820 REM PET AIM CONNECTION
825 REM ALAN K. CHRISTENSEN
830 REM JULY 20, 1981
```

Listing 3

```
;PET$AIM$ASM.C
;AIM TO PET LOADER INTERFACE
;BY ALAN K. CHRISTENSEN
;AUSTIN, TEXAS
;JULY 20, 1981
;
;PET DEPENDANT ADDRESSES
;PET 1.0 ADDRESSES GIVEN
ADDR    = $58 ;USE END OF BASIC INPUT BUFFER
              ;TO STORE ADDRESS. THE BYTES
              ;WILL BE RESTORED AT EXIT
CKSTOP = 62250 ;ROUTINE TO CHECK FOR STOP KEY
         (Upgrade - 62209, 4.0 - 62261)
;
;
         JMP INIT ;USR(0) ENTRY
;
         *=$2200
MSG      = *
FCHMSG .BYTE 13,'FINAL '
CHKMSG .BYTE 'CHECK SUM '
       .BYTE 'ERROR',13
CHKLEN = *-CHKMSG
FCHLEN = *-FCHMSG
;
RECMSG .BYTE 13,'RECORD NUMBER '
       .BYTE 'MISMATCH ERROR',13
RECLEN  = *-RECMSG
;
DONE    .BYTE 13,'DONE',13
DONEL   = *-DONE
;
;LINE 100
GETAIM = * ;GET 1 BYTE FROM THE AIM
       LDA P0      ;PULSE CB2
       STA PCR     ;FIRST LOW
       LDA P1      ;THEN HIGH
       STA PCR     ;TO MAKE HANDSHAKE
;
FLAGCK JSR CKSTOP  ;CHECK FOR STOP KEY
       BEQ EXITI    ;TO  LEAVE LOOP
;
;LINE 105
       LDA ITFR    ;CHECK THE INTERRUPT FLAG
       AND #CA1    ;REGISTER FOR READY
       BEQ FLAGCK ;SIGNAL FROM AIM
```

(Continued)

Listing 3 *(Continued)*

```
;
;LINE 110
        LDA REGA    ;GET 1 BYTE FROM INTERFACE
        PHA


;
;LINE 115
        LDA #CA1    ;CLEAR THE INTERRUPT FLAG
        STA ITFR
;
;LINE 120
;
        PLA         ;RETURN
        RTS
;
;LINE 300-310
;
G2BYTS  JSR GETBYT  ;GET 2 ASCII BYTES
        TAX         ;THE 1ST IN X
;                   ;AND THE SECOND IN A
;LINE 200
;
GETBYT  JSR GETAIM  ;GET 1 ASCII BYTE FROM AIM
        SEC         ;AND CONVERT THE ASCII
        SBC #'0'      ;HEX INTO BINARY
        CMP #10     ;
        BCC HEX1    ;RETURN BYTE IN A
        SBC #7
HEX1    ASL A
        ASL A       ;MULTIPLY 1ST DIGIT
        ASL A       ;BY 16
        ASL A
        STA DIGIT1
;
;LINE 205
;
        JSR GETAIM  ;GO FOR THE
        SEC         ;SECOND DIGIT
        SBC #'0'
        CMP #10
        BCC HEX2
        SBC #7
HEX2    =   *
;
;LINE 210
;
        ORA DIGIT1  ;COMBINE THE 1ST AND 2ND DIGIT
;
;LINE 215
;
        PHA         ;ADD THIS BYTE TO THE
        CLC         ;CHARACTER COUNT
        ADC KKSUM+1
        BCC ADD1
        INC KKSUM
ADD1    STA KKSUM+1
        PLA

;
;LINE 220
;
        RTS         ;RETURN
;
EXITI   LDX SAVSTK  ;RESET STACK POINTER
        TXS         ;TO ALLOW EXIT FROM
        JMP EXITT   ;WITHIN SUBROUTINE
;
;LINE 400
;
LOADER = *          ;LOAD A RECORD IN AIM FORMAT
        JSR GETAIM  ;LOOK FOR THE SEMI-
        CMP #';'    ;COLON THAT STARTS
        BNE LOADER  ;THE RECORD
;
;LINE 405
;
        LDY #0      ;RESET THE CHARACTER COUNTER
        STY KKSUM   ;TO COUNT ALL CHARACTERS
        STY KKSUM+1 ;AFTER THE ';'
        INC NREC+1
        BNE ADD2     ;ADD 1 TO NUMBER OF RECORDS
        INC NREC
ADD2    =   *
;
```

Listing 3 *(Continued)*

```
;LINE 410
;
        JSR GETBYT ;FIRST BYTE OF RECORD IS
        AND #$1F   ;THE DATA BYTE COUNT
        STA COUNT  ;AND SHOULD BE <= 24
;
;LINE 415
;
        BEQ LAST   ;CHECK FOR LAST RECORD
;
;LINE 420
;
        JSR G2BYTS ;GET THE BASE ADDRESS
        STX ADDR+1 ;FOR THE DATA BYTES
        STA ADDR   ;AND SAVE IN ZERO PAGE

;
;LINE 425
;
FLOOP1 =   *       ;Y=0 FROM LINE 405
;
;LINE 430
;
        JSR GETBYT ;GET THE DATA BYTES
        STA ARRAY,Y ;AND SAVE THEM IN ARRAY


;
;LINE 435
;
        INY        ;LOOP BACK FOR ALL BYTES
        CPY COUNT  ;
        BNE FLOOP1 ;
;
;LINE 440
;
        LDA KKSUM   ;THE ACCUMULATED SUM
        STA CHKSUM  ;OF THE BYTES SO FAR
        LDA KKSUM+1 ;ARE EQUIVALENT TO
        STA CHKSUM+1 ;THE CHECK SUM
;
;LINE 445
;
        JSR G2BYTS ;GET THE CHECKSUM
;                  ;FROM THE RECORD
;LINE 450
;
        CMP CHKSUM+1 ;CHECK CALCULATED
        BNE CHKERR   ;CHECKSUM WITH
        CPX CHKSUM   ;RECORD CHECK
        BNE CHKERR   ;SUM
;
;LINE 455
;
        LDY #0     ;SET UP DATA-
FLOOP2 =   *       ;BYTE STORE LOOP
;
;LINE 460
;
        LDA ARRAY,Y ;STORE ALL DATA BYTES
        STA (ADDR),Y
;
;LINE 465
;
        INY        ;INCREASE ADDRESS OF STORE
;
;LINE 470
;
        CPY COUNT  ;CHECK FOR FINISHED
        BNE FLOOP2
;
;LINE 480
;
        JMP LOADER ;GO BACK FOR NEXT RECORD
;
;LINE 500
;
LAST    JSR G2BYTS ;GET NUMBER OF RECORDS SENT
;
;LINE 505
;
        CMP NREC+1 ;COMPARE TO NUMBER OF
        BNE RECERR ;RECORDS RECEIVED
        CPX NREC   ;A MISMATCH INDICATES
        BNE RECERR ;THAT DATA WAS LOST
```

Listing 3 *(Continued)*

```
;
;LINE 510
;
        LDA KKSUM+1  ;MOVE THE CHARACTER
        STA CHKSUM+1 ;COUNT INTO CHECKSUM
        LDX KKSUM    ;
        STX CHKSUM   ;
;
;LINE 520
;
        JSR G2BYTS ;GET FINAL CHECKSUM
;
;LINE 525
;
        CMP CHKSUM+1 ;CHECKSUM SHOULD BE
        BNE FCHERR ;A GUARD FOR THE
        CPX CHKSUM   ;RECORD COUNT
        BNE FCHERR
;
;LINE 530
;
        JSR GETAIM ;CLEAR REMAINING CARRIAGE
;
;LINE 535
;
        JSR GETAIM ;RETURNS TO FREE AIM
;
;LINE 540
;
EXIT    LDX #DONE-MSG ;PRINT 'DONE'
        LDY #DONEL
        JSR PRTMSG
;
EXITT   LDA SAVEZP ;RESTORE ZERO PAGE
        STA ADDR   ;USED BY ADDRESS
        LDA SAVEZP+1
        STA ADDR+1
        RTS           ;RETURN TO CALLING PROGRAM
;
CHKERR LDX #CHKMSG-MSG ;CHECKSUM ERROR
        LDY #CHKLEN     ;PRINT MESSAGE
MSGXIT JSR PRTMSG      ;AND RETURN
        JMP EXITT
;
FCHERR LDX #FCHMSG-MSG ;FINAL CHECK-
        LDY #FCHLEN     ;SUM ERROR
        BNE MSGXIT
;
RECERR LDX #RECMSG-MSG ;RECORD COUNT
        LDY #RECLEN     ;ERROR
        BNE MSGXIT
;
;LINES 600-650
;
ARRAY  *=*+24    ;VARIABLE STORAGE
DIGIT1 *=*+1
CHKSUM *=*+2
KKSUM  *=*+2
NREC   *=*+2
;
COUNT  *=*+1
P0     *=*+1
P1     *=*+1
SAVEZP *=*+2
SAVSTK *=*+1
;
;LINES 655-670
;
PCR    = 59468 ;PERIFERAL CONTROL REGISTER
REGA   = 59471 ;A PORT DATA REGISTER
ITFR   = 59469 ;INTERRUPT FLAG REGISTER
DDRA   = 59459 ;A PORT DATA DIRECTION REGISTER
CA1    = 2     ;MASK FOR CA1 INTERRUPT FLAG
;
INIT   LDA ADDR   ;INITIALIZATION
       STA SAVEZP
       LDA ADDR+1 ;SAVE ZERO PAGE LOCATION
       STA SAVEZP+1 ;USED BY ADDR
;
       TSX        ;SAVE THE STACK POINTER
       STX SAVSTK ;SO STOP KEY CAN EXIT
;
;LINE 675
;
       LDA PCR    ;SAVE THE BITS FROM PCR
       AND #$1E   ;THAT ARE NOT USED IN INTERFACE
```

Listing 3 *(Continued)*

```
;
;LINE 680
;
        ORA #$C0    ;CB2 LOW
        STA P0
;
;LINE 685
;
        ORA #$E0     ;CB2 HIGH
        STA P1
;
;LINE 730
;
        LDA #0      ;ZEROS MAKE DATA DIRECTION
        STA DDRA    ;INTO INPUTS
;
        STA NREC    ;INITIALIZE RECORD
        STA NREC+1  ;COUNTER
;
;LINE 735
;
        JMP LOADER
;
;
; SUBROUTINE TO PRINT A MESSAGE TO THE PET SCREEN
;X POINTS TO MESSAGE WITHIN PAGE LENGTH OF MSG
;Y IS THE LENGTH OF THE MESSAGE
PRINT=$FFD2 ;PET 2001 PRINT CHARACTER
;
PRTMSG = *
;
;
LDA MSG,X
JSR PRINT
INX
DEY
BNE PRTMSG
RTS
;
.END
```

MICRO

PET to AIM Download

by George Watson

A fast, reliable method is presented for transfer of programs from the PET microcomputer to the AIM 65 (or other micro with an accessible 6522). Macroassemblers available for the PET may thus be easily used for developing AIM, SYM, and KIM programs.

PET to AIM
requires:

PET
AIM 65 or SYM
Interface cable (see page 12)

During the past several years, a wide range of computers has been developed based on the 6502 microprocessor. With such a wide spectrum it is possible to choose a system tailored specifically for a given job. A microcomputer with high-level languages, disk storage, and a plethora of peripheral equipment can be chosen for an application requiring extensive data analysis or file management. For simply controlling a piece of equipment though, a more reasonable and economical choice may be a single board computer. When both types of systems are present the thought naturally occurs that any type of program development for the bare bones system should be implemented using the full-blown system. Assembler source files and object code may be easily created with powerful macroassemblers or compilers. Then the object code needs only to be transferred to the less-expanded computer. Specifically, I would like to consider the downloading of machine code from the PET/CBM to the AIM 65.

The hardware requirements for transfer of data between two computers are: 1) an output port, 2) an input port, and 3) wires connecting the two ports. Many 6502 computers make available to the user a parallel port consisting of a 6522, the Versatile Interface Adapter. The AIM 65 has two 8-bit ports with

Listing 1: **AIM Initialization Routine. Runs in AIM.**

```
          ;**************************
          ;* AIM-FROM-PET DOWNLOAD *
          ;*     GEORGE WATSON      *
          ;*     FEB. 8, 1982       *
          ;**************************
          ;
          ;************************
          ;* ASSEMBLY DIRECTIVES *
          ;************************
          ;
                       .BA $0200
                       .CE
                       .LS
          ;
          ;***************************
          ;* AIM J1 CONNECTION PORT *
          ;***************************
          ;
          VIA          .DE $A000           ;BASE ADDRESS OF AIM 6522
                                           ;SYM VIA #2: $A800
          ORAH         .DE VIA+$01         ;PORT A WITH HANDSHAKING
          DDRA         .DE VIA+$03         ;DATA DIRECTION REGISTER A
          PCR          .DE VIA+$0C         ;PERIPHERAL CONTROL REG.
          IFR          .DE VIA+$0D         ;INTERRUPT FLAG REGISTER
          ;
          ;**********************
          ;* PROGRAM VARIABLES *
          ;**********************
          ;
          START        .DE $00             ;START ADDRESS OF PROGRAM
          LENGTH       .DE $02             ;LENGTH OF PROGRAM
          ;
          ;********************
          ;* INITIALIZE PORT *
          ;********************
          ;
0200- A9 00    PORTINIT     LDA #0         ;SET PORT A AS INPUT
0202- 8D 03 A0              STA DDRA
0205- A9 09                 LDA #9         ;SET CA2 OUTPUT HANDSHAKE
0207- 8D 0C A0              STA PCR        ; MODE WITH CA1 INT FLAG
          ;                                  SET ON RISING EDGE
020A- AD 01 A0              LDA ORAH       ;CLEAR PORT
          ;
          ;*********************************
          ;* GET START ADDRESS AND LENGTH *
          ;*********************************
          ;
020D- 20 39 02 ADDRESS      JSR PORTGET    ;LOAD LOW THEN HIGH BYTE
0210- 85 00                 STA *START
0212- 20 39 02              JSR PORTGET
0215- 85 01                 STA *START+1
0217- 20 39 02              JSR PORTGET
021A- 85 02                 STA *LENGTH
021C- 20 39 02              JSR PORTGET
021F- 85 03                 STA *LENGTH+1
          ;
          ;*********************
          ;* DOWNLOAD PROGRAM *
          ;*********************
          ;
0221- A2 00    DOWNLOAD     LDX #0         ;TRANSFER PROGRAM
0223- A0 00                 LDY #0
0225- 20 39 02 NEXTBYTE     JSR PORTGET    ;LOAD BYTE
0228- 91 00                 STA (START),Y
022A- C8                    INY
022B- D0 03                 BNE SKIP1
022D- E8                    INX            ;GOTO NEXT PAGE
022E- E6 01                 INC *START+1
0230- E4 03    SKIP1        CPX *LENGTH+1  ;END OF PROGRAM?
0232- D0 F1                 BNE NEXTBYTE
0234- C4 02                 CPY *LENGTH
0236- D0 ED                 BNE NEXTBYTE
0238- 00       EXIT         BRK
```

complete handshaking signals available. PET/CBM has one 8-bit port with partial support for handshaking. Pinouts for construction of the cable are given on page 12.

The program required in the AIM (listing 1) is very short and consists of four sections: initialization, start and length parameters, downloading, and the port input subroutine. With the VIA address substitutions given, the program should run on the SYM, using its VIA #2. As assembled, the program resides in the second page of memory and may be entered *via* the AIM monitor. This program is run by setting the program counter < * >0200, and entering <G>. The AIM should always be initialized before the PET begins the transfer.

The PET program requests that input of the AIM start address, and the PET start and end address of the program, be transferred. (See listing 2.) All addresses should be given as 4-digit hex numbers. These addresses are input using a routine present in the PET monitor. If an error is made in entry, the user will be returned to the monitor with a "." prompt; exit with X and start again. The program has been preceded with a single line of BASIC (10 SYS1037) so that RUN causes execution of the download. Any editing or variable use at this point will destroy the program.

I usually download code to the AIM immediately after assembling it with Carl Moser's MAE macroassembler. After assembly, the end address (+1) of the stored object code is stored at $7651,$7652. Unfortunately it seems that the start address and offset address are not stored (although they are present in the source file). By replacing the section entitled * GET PET END ADDRESS * as follows we need only enter the PET and AIM start address and not be concerned with the program length.

```
MAEEND >   DE $7651
HEXOUT     DE $D722
;
PETEND        LDY #H,STR3
              LDA #L,STR3
              JSR STROUT
              LDA MAEEND + 1
              STA END + 1
              JSR HEXOUT
              LDA MAEEND
              STA END
              JSR HEXOUT
```

Transferring programs between microcomputers equipped with 6522

Listing 1 *(Continued)*

```
                ;
                ;*****************
                ;* VIA PORT GET *
                ;*****************
                ;
0239- AD 0D A0  PORTGET    LDA IFR          ;WAIT FOR DATA READY
023C- 29 02                AND #2           ; SIGNAL
023E- F0 F9                BEQ PORTGET
0240- AD 01 A0             LDA ORAH         ;RECEIVE BYTE
0243- 60                   RTS
                ;
                           .EN
END OF MAE PASS!
```

Listing 2: **PET to AIM Download. Runs in PET.**

```
END OF MAE PASS!

                ;************************
                ;* PET-TO-AIM DOWNLOAD *
                ;*    GEORGE WATSON    *
                ;*    FEB. 4, 1982     *
                ;************************
                ;
                ;************************
                ;* ASSEMBLY DIRECTIVES *
                ;************************
                ;
                           .BA $0400        ;NORMAL START OF BASIC
                           .CE
                           .OS
                           .LS
                ;
                ;************************
                ;* USER PORT VARIABLES *
                ;************************
                ;
                VIA        .DE $E840        ;BASE ADDRESS OF PET 6522
                ORAH       .DE VIA+$01      ;PORT A WITH HANDSHAKING
                DDRA       .DE VIA+$03      ;DATA DIRECTION REGISTER A
                PCR        .DE VIA+$0C      ;PERIPHERAL CONTROL REG.
                IFR        .DE VIA+$0D      ;INTERRUPT FLAG REGISTER
                ;
                ;*********************
                ;* SYSTEM VARIABLES *
                ;*********************
                ;
                ;ROM VERSION   4.0           UPGRADE
                ;
                KEYBUF     .DE $9E          ;       # OF KEYSTROKES
                HEXIN      .DE $FB          ;       LOW BYTE OF ADDRESS
                HEXINPUT   .DE $D754        ;$E7A7 HEX ADDRESS INPUT
                STROUT     .DE $BB1D        ;$CA1C PRINT STRING
                RDT        .DE $FFCF        ;       INPUT CHARACTER
                ;
                ;**********************
                ;* PROGRAM VARIABLES *
                ;**********************
                ;
                PET        .DE $00          ;PET START ADDRESS
                END        .DE HEXIN        ;PET END ADDRESS
                LEN        .DE HEXIN        ;PROGRAM LENGTH
                PCRWAS     .DE STORE        ;ORIGINAL PET PCR VALUE
                ;
                SENT       .DE %00100000    ;ORA WITH PCR
                TAKEN      .DE %11011111    ;AND WITH PCR
                SETUP      .DE %11000000    ;CB2 HANDSHAKE
                ;
                ;*******************
                ;* BASIC RUN START *
                ;*******************
                ;
0400- 00        BASIC      .BY $0           ;START OF BASIC
0401- 0B 04                .BY $B $4 ;       LINE LINK
0403- 0A 00                .BY $A $0 ;       LINE NUMBER 10
0405- 9E                   .BY $9E          ;SYS
0406- 31 30 33             .BY '1037'       ;DECIMAL ADDRESS
0409- 37
040A- 00 00 00             .BY $0 $0 $0 ;    END OF BASIC
                ;
                ;*****************************
                ;* INITIALIZE PET USER PORT *
                ;*****************************
                ;
                START
                ;
040D- A9 FF     PORTINIT   LDA #$FF         ;SET PORT A AS OUTPUT
040F- 8D 43 E8             STA DDRA
0412- AD 4C E8             LDA PCR          ;SAVE CONTENTS OF PCR
0415- 8D 09 05             STA PCRWAS
0418- 29 DF                AND #TAKEN
041A- 09 C0                ORA #SETUP       ;USE CB2 AS MANUAL HANDSHAKE
041C- 8D 4C E8             STA PCR
                ;
                ;*************
                ;* SETUP AIM *
                ;*************
                ;
041F- A0 04     AIMSETUP   LDY #H,STR0      ;MAKE SURE THAT AIM IS
```

Listing 2

```
0421- A9 AB                 LDA #L,STR0         ; WAITING FOR TRANSFER
0423- 20 1D BB              JSR STROUT
0426- A9 00                 LDA #0
0428- 85 9E                 STA *KEYBUF
042A- 20 CF FF              JSR RDT
                  ;
                  ;**********************************
                  ;* GET & SEND AIM START ADDRESS *
                  ;**********************************
                  ;
042D- A0 04       AIMSTART  LDY #H,STR1         ;INPUT 4 DIGIT ADDRESS
042F- A9 CB                 LDA #L,STR1         ; AT WHICH PROGRAM SHOULD
0431- 20 A0 04              JSR INPUT           ; BE STORED IN AIM
0434- A5 FB                 LDA *HEXIN
0436- 20 85 04              JSR PORTSEND
0439- A5 FC                 LDA *HEXIN+1
043B- 20 85 04              JSR PORTSEND
                  ;
                  ;*************************
                  ;* GET PET START ADDRESS *
                  ;*************************
                  ;
043E- A0 04       PETSTART  LDY #H,STR2         ;INPUT ADDRESS AT WHICH
0440- A9 EF                 LDA #L,STR2         ; PROGRAM STARTS IN PET
0442- 20 A0 04              JSR INPUT
0445- A5 FB                 LDA *HEXIN
0447- 85 00                 STA *PET
0449- A5 FC                 LDA *HEXIN+1
044B- 85 01                 STA *PET+1
                  ;
                  ;***********************
                  ;* GET PET END ADDRESS *
                  ;***********************
                  ;
044D- A0 04       PETEND    LDY #H,STR3         ;INPUT ADDRESS OF FIRST
044F- A9 FC                 LDA #L,STR3         ; BYTE AFTER END OF
0451- 20 A0 04              JSR INPUT           ; PROGRAM IN PET
```

(Continued on next page)

Versatile Interface Adapters is not a difficult task. Better, more efficient program development will result by using the most powerful system available, even though the program will reside in a different computer. A small revision in a program no longer requires time spent with simple assemblers and tape files, or in entering object code repeatedly by hand. I would like to acknowledge the previous efforts and gains made on the PET/AIM system by Dr. John H. Miller, III and Dr. Michael Ryschkewitsch.

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Listing 2 *(Continued)*

```
                 1190 ;****************************
                 1200 ;* CALCULATE & SEND LENGTH *
                 1210 ;****************************
                 1220 ;
0454- 38         1230 LENGTH     SEC                ;SUBTRACT END ADDRESS
0455- A5 FB      1240            LDA *END           ; FROM START ADDRESS
0457- E5 00      1250            SBC *PET           ; TO FIND PROGRAM LENGTH
0459- 85 FB      1260            STA *LEN
045B- 20 85 04   1270            JSR PORTSEND
045E- A5 FC      1280            LDA *END+1
0460- E5 01      1290            SBC *PET+1
0462- 85 FC      1300            STA *LEN+1
0464- 20 85 04   1310            JSR PORTSEND
                 1320 ;
                 1330 ;********************
                 1340 ;* DOWNLOAD PROGRAM *
                 1350 ;********************
                 1360 ;
0467- A2 00      1370 DOWNLOAD   LDX #0             ;TRANSFER PROGRAM
0469- A0 00      1380            LDY #0
046B- B1 00      1390 NEXTBYTE   LDA (PET),Y        ;SEND BYTE
046D- 20 85 04   1400            JSR PORTSEND
0470- C8         1410            INY
0471- D0 03      1420            BNE SKIP1
0473- E8         1430            INX                ;GOTO NEXT PAGE
0474- E6 01      1440            INC *PET+1
0476- E4 FC      1450 SKIP1      CPX *LEN+1         ;END OF PROGRAM?
0478- D0 F1      1460            BNE NEXTBYTE
047A- C4 FB      1470            CPY *LEN
047C- D0 ED      1480            BNE NEXTBYTE
                 1490 ;
047E- AD 09 05   1500 EXIT       LDA PCRWAS         ;RESTORE PET
0481- 8D 4C E8   1510            STA PCR
0484- 60         1520            RTS
                 1530 ;
                 1540 ;*****************
                 1550 ;* VIA PORT SEND *
                 1560 ;*****************
                 1570 ;
0485- 8D 41 E8   1580 PORTSEND   STA ORAH           ;PLACE BYTE AT PORT A
0488- AD 4C E8   1590            LDA PCR
048B- 09 20      1600            ORA #SENT          ;SET DATA SENT SIGNAL
048D- 8D 4C E8   1610            STA PCR
0490- AD 4D E8   1620 WAIT       LDA IFR            ;WAIT FOR DATA RECEIVED
0493- 29 02      1630            AND #2             ; SIGNAL
0495- F0 F9      1640            BEQ WAIT
0497- AD 4C E8   1650            LDA PCR            ;RESET DATA SENT SIGNAL
049A- 29 DF      1660            AND #TAKEN
049C- 8D 4C E8   1670            STA PCR
049F- 60         1680            RTS
                 1690 ;
                 1700 ;*****************
                 1710 ;* INPUT ROUTINE *
                 1720 ;*****************
                 1730 ;
04A0- 20 1D BB   1740 INPUT      JSR STROUT         ;PRINT INPUT PROMPT
04A3- A9 00      1750            LDA #0             ;EMPTY KEYBOARD BUFFER
04A5- 85 9E      1760            STA *KEYBUF
04A7- 20 54 D7   1770            JSR HEXINPUT       ;INPUT HEX ADDRESS
04AA- 60         1780            RTS
                 1790 ;
                 1800 ;*************************
                 1810 ;* INPUT PROMPT MESSAGES *
                 1820 ;*************************
                 1830 ;
04AB- 0D 50 52   1840 STR0       .BY $D 'PREPARE AIM, THEN HIT RETURN. ' 0
04AE- 45 50 41
04B1- 52 45 20
04B4- 41 49 4D
04B7- 2C 20 54
04BA- 48 45 4E
04BD- 20 48 49
04C0- 54 20 52
04C3- 45 54 55
04C6- 52 4E 2E
04C9- 20 00
04CB- 0D 0D 45   1850 STR1       .BY $D $D 'ENTER HEX ADDRESSES:' $D
04CE- 4E 54 45
04D1- 52 20 48
04D4- 45 58 20
04D7- 41 44 44
04DA- 52 45 53
04DD- 53 45 53
04E0- 3A 0D
04E2- 0D 41 49   1860            .BY $D 'AIM START? ' 0
04E5- 4D 20 53
04E8- 54 41 52
04EB- 54 3F 20
04EE- 00
04EF- 0D 50 45   1870 STR2       .BY $D 'PET START? ' 0
04F2- 54 20 53
04F5- 54 41 52
04F8- 54 3F 20
04FB- 00
04FC- 0D 50 45   1880 STR3       .BY $D 'PET END?   ' 0
04FF- 54 20 45
0502- 4E 44 3F
0505- 20 20 20
0508- 00
0509- 00         1890 STORE      .BY 0
                 1900 ;
                 1910            .EN
END OF MAE PASS!
```

MICRO™

Expanding File Cabinet for the Apple

by David P. Allen

The public domain "File Cabinet" is still in use by many Apple owners. Techniques to access "File Cabinet" data for use in other programs are presented.

File Cabinet
requires:

Apple II or Apple II Plus
48K
Applesoft in ROM

An axiom of executive efficiency experts is "Never handle a piece of paper more than once." When you get a paper, finish with it completely before you set it down.

There is a parallel to this idea when it comes to managing data with a computer: "Never enter the same data more than once through the keyboard." Once entered, we should be able to do just about anything we want with it — sort it, select items, make labels, edit, etc.

Several programs for sale do exactly that. They're called data managers, and most of them are very good. They are also among the most expensive software items being sold today.

One data manager has been around for almost as long as the Apple II itself. One of its best features is that it is almost free. I am talking about the reliable but often-sneered-at FILE CABINET program that originally appeared on one of the first Apple-supplied "Contributed Programs" disks. This program and its progeny have been used for many tasks by Apple users. In spite of its shortcomings (and there are a few), it continues to have a life undiminished.

One reason for this is the great volume of data that has been translated into FILE CABINET index files. Before you know it, you have spent so much time entering information into this electronic cabinet that the thought of entering all that material through the keyboard again is unthinkable. Finding myself in this position, but still wanting to move batches of information from the FILE CABINET to other application programs, I decided to investigate whether there is a way to link the FILE CABINET with other programs.

Figure 1

```
]CATALOGD1

DISK VOLUME 254

K80N
  REC#: 1
1 CITY: ALBANY NY
2 LAT.: 42.65
3 LONG.: -73.75

K80N
  REC#: 2
1 CITY: ANNAPOLIS MD
2 LAT.: 38.98
3 LONG.: -76.50

K80N
  REC#: 3
1 CITY: ATLANTA GA
2 LAT.: 33.75
3 LONG.: -84.39

K80N
  REC#: 4
1 CITY: AUGUSTA ME
2 LAT.: 44.31
3 LONG.: -69.77

K80N
  REC#: 5
1 CITY: AUSTIN TX
2 LAT.: 30.26
3 LONG.: -97.74

K80N
  REC#: 6
1 CITY: BATON ROUGE LA
2 LAT.: 30.45
3 LONG.: -91.18

K80N
  REC#: 7
1 CITY: BISMARCK ND
2 LAT.: 46.81
3 LONG.: -100.79

K80N
  REC#: 8
1 CITY: BOISE ID
2 LAT.: 43.62
3 LONG.: -116.2
```

I soon developed a simple program to do just that. Before analyzing this program, let's take a look at what we are starting with, and what we are going to wind up with. To make things clear, we'll use some real data.

The example I have chosen is data for a GREAT CIRCLE program which computes distances and bearings to various places in the country. To accomplish this task the GREAT CIRCLE program needs the identity (city and state), plus the latitude and longitude of the distant city. This information is entered into a file in the FILE CABINET program. A typical printout of the records of this file appears in figure 1. Each record contains the data on one location.

As with most Applesoft programs, the GREAT CIRCLE program works on data in the form of DATA statements. Figure 2 shows a listing of some of the data statement lines from the GREAT CIRCLE program. Our task, then, is to get the information out of the FILE CABINET records and into the data statements of GREAT CIRCLE. The program listing NA DATA WRITER EXEC does the trick.

Line 1 establishes three maxfiles; a necessity if we have been playing around with FILE CABINET which reduces maxfiles to one. Line 100 shows us what is going on. Line 300 sets up the program to wind things up after the last piece of data has been read. Lines 400 to 600 establish a file called "NA DATA WRITER", while line 700 determines the line number of the first data statement to be used in the final program. Lines 800 and 900 open up the FILE CABINET index file, in this case called "NA BEARINGS INDEXFILE". Figure 3 shows us the contents of this file as compiled by FILE CABINET. It reveals that all of the needed data is nicely arranged in the order that we need it. Depending on which version of the FILE CABINET program we are using, there is some

'housekeeping' information stored as a preamble to the meat of the file. In this case, just before the first entry, 'ALBANY NY', there is the figure 51, which represents the number of records currently existing in this indexfile. Necessary information for FILE CABINET, but a problem for GREAT CIRCLE.

Looking at NA DATA WRITER, we see that lines 1000 to 1300 read out the data from the indexfile into strings A through D. Line 1500 starts writing this information into the text file NA DATA WRITER. Lines 1600 and 1700 start the data statement with a line number and the reserved word DATA. Line 1800 increments the line number counter, line 1900 writes in the information stored in B$, C$, and D$, and line 2000 prepares for more data. Line 2100 starts us through the process over again. Note that A$ is collected once and not used. This is the housekeeping data and is collected just to get it out of the way. Consequently, we loop back to line 1100 and not line 1000. When we run out of data the program jumps to line 2400 where it prints out a final data statement containing the 'END DATA' string, which the GREAT CIRCLE program needs to complete its assignment.

Here is the way this routine is brought into play. First we enter all our data into the FILE CABINET program. We can sort, change, delete, or add records as we wish. When we have the information the way we want it, it is stored in the INDEXFILE, in this case NA BEARINGS INDEXFILE. Now we load and run our interconnecting program, NA DATA WRITER EXEC. This program must be run with the disk containing the FILE CABINET file, NA BEARINGS INDEXFILE, in the disk drive. It will create the text file, NA DATA WRITER.

We now load the program that we wish to add the data statements to, in this case GREAT CIRCLE. At this point we delete any old data statements which may exist in the block of data statement numbers we are about to add. In this example we would delete lines 3000 through 3999. We are now ready for the final step.

With the disk containing the text file NA DATA WRITER in the slot, we exec this file. This file, shown in figure 4, is added to GREAT CIRCLE and the data statements are now added. Our task is complete.

The advantage of this system is that it can be adapted to almost any program that can use data statements. We can use the FILE CABINET program to manipulate our raw data into the form we want before committing it to data statements. I'm sure you can find lots of ways to use this procedure to shuttle basic data from file cabinet files to a variety of other programs.

The author may be contacted at 19 Damon Road, Scituate, MA 02066.

Figure 2

```
3000  DATA ALBANY NY,42.65,-73.75
3003  DATA ANNAPOLIS MD,38.98,
      -76.50
3006  DATA ATLANTA GA,33.75,-84.39
3009  DATA AUGUSTA ME,44.31,-69.77
3012  DATA AUSTIN TX,30.26,-97.74
3015  DATA BATON ROUGE LA,30.45,
      -91.18
3018  DATA BISMARCK ND,46.81,
      -100.79
3021  DATA BOISE ID,43.62,-116.2
```

Figure 3:
Printout of NA Indexfile Bearings

```
51
ALBANY NY
42.65
-73.75
ANNAPOLIS MD
38.98
-76.50
ATLANTA GA
33.75
-84.39
AUGUSTA ME
44.31
-69.77
AUSTIN TX
30.26
-97.74
BATON ROUGE LA
30.45
-91.18
BISMARCK ND
46.81
-100.79
BOISE ID
43.62
-116.2
```

***Figure 4:* Printout of NA Data Writer**

```
 1  PRINT "MAXFILES 3": REM   CONTROL-D AFTER FIRST QUOTE
 2 DEE$ =  CHR$ (4): REM   CONTROL-D
 100  PRINT DEE$;"MON C,I,O"
 200  REM


 <<< NA DATA WRITER EXEC >>>

      by David P. Allen

        July 14, 1981


300  ONERR  GOTO 2400
400  PRINT DEE$;"OPEN NA DATA WRITER"
500  PRINT DEE$;"DELETE NA DATA WRITER"
600  PRINT DEE$;"OPEN NA DATA WRITER"
700 LINENUMBER = 3000
800  PRINT DEE$;"OPEN NA BEARINGS INDEXFILE"
900  PRINT DEE$;"READ NA BEARINGS INDEXFILE"
1000  INPUT A$
1100  INPUT B$
1200  INPUT C$
1300  INPUT D$
1500  PRINT DEE$;"WRITE NA DATA WRITER"
1600  PRINT LINENUMBER;
1700  PRINT "DATA";
1800 LINENUMBER = LINENUMBER + 3
1900  PRINT B$;",";C$;",";D$
2000  PRINT DEE$;"READ NA BEARINGS INDEXFILE"
2100  GOTO 1100
2200  PRINT DEE$;"CLOSE"
2300  END
2400 LINENUMBER = LINENUMBER + 3
2500  PRINT DEE$;"WRITE NA DATA WRITER"
2600  PRINT LINENUMBER;
2700  PRINT "DATA";
2800  PRINT "END DATA 1,1,1
2900  GOTO 2200
```

MICRO™

Duty Cycle Monitor for the VIC-20

by Bob Kovacs

This VIC-20 utility program determines the correct volume level when reading cassette tapes from a conventional tape recorder. Techniques are presented for using the VIC's built-in timers in conjunction with a machine-language program to measure waveform pulse widths. In addition, an interface circuit is provided.

Duty Cycle Monitor requires:

VIC-20 with properly interfaced cassette recorder.
May be modified for Apple.

Although the VIC-20 cassette tape interface was designed for use with Commodore's own data tape recorder, it can readily be adapted for use with a standard audio tape recorder. My own design (see figure 1) has proven adequate, although several variations are possible.

In general, the output of the adapter circuit will be dependent on the playback volume level. At least three conditions must be satisfied before consistent, error-free loading can be attained. First, there must be sufficient amplitude to exceed the adapter's detection threshold. Next, the level must be such that the "sync" tone at the beginning of the tape has a 50 percent duty cycle. (This tone is easily distinguished from the noisy sounds of data by actually listening to the tape. I've modified my recorder as shown in figure 2 so that I can hear these sounds during a LOAD.) Then, the variability (i.e. jitter) in both the playback frequency and duty cycle must be limited.

The ability to read tapes is a function of how they were recorded. Tapes played back on the machine on which they were recorded are generally read more easily than those recorded elsewhere. This is primarily due to variations in recording head alignment from

Figure 1: **VIC-20 Cassette Tape Recorder Adapter**

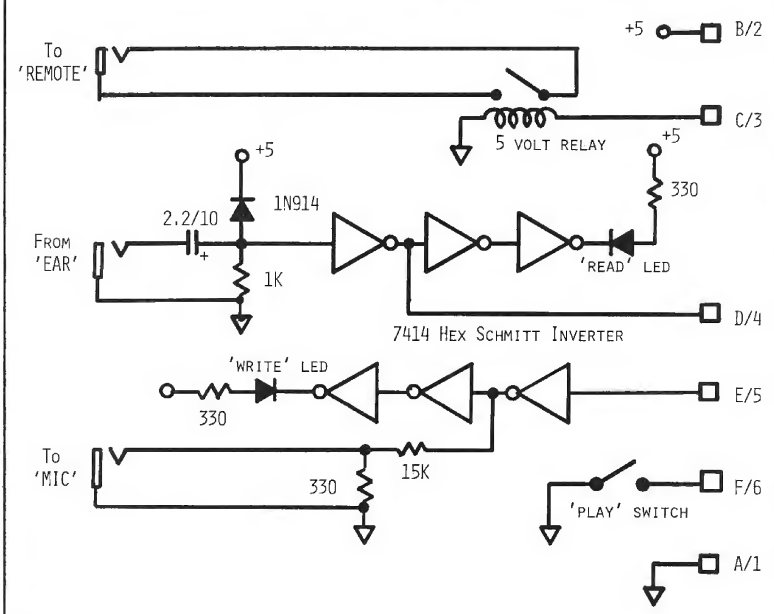
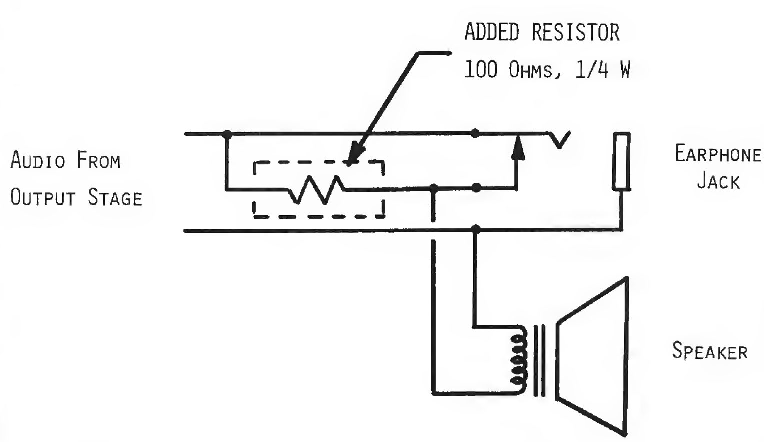


Figure 2: **Cassette Recorder Modification — Allows tape to be heard at reduced volume during a 'LOAD'**



one machine to another, which can have a significant effect on preserving the fidelity of the waveform during playback. Most recorders are provided with a small alignment screw near the record/playback heads.

Setting the volume level is usually done by trial and error. Eventually upper and lower level limits are established so that a given tape can be read consistently. Tapes that originated on other recorders can occasionally be troublesome, making the whole process frustrating. The program shown in listing 1 is an aid for establishing the proper volume level and for assessing playback jitter. It does this by separately measuring the duration of the positive and negative portions of the playback waveform. The results are displayed graphically for ease of interpretation so that a sync tone having a 50 percent duty cycle is displayed with equal positive and negative values. In addition, the stability of the display is a direct indication of phase and frequency jitter due to amplitude variations and motor speed fluctuations.

The Duty-Cycle program presented here is easy to use. Just run the program while playing the tape to be loaded. The volume level is adjusted during the sync tone until the display indicates a 50 percent duty cycle. This condition is met when the two "+" symbols line up. After the level is adjusted, the program is halted and the tape is read in using the LOAD command. (If your tape recorder also has a tone control, then it should be set for maximum treble.)

How it Works

A machine-language routine (shown in listing 2) performs the main task of measuring and displaying pulse widths. This routine is already incorporated in DATA statements of the BASIC program in listing 1. The routine was initially developed, assembled and tested on an Apple II using a John Bell dual 6522 VIA parallel board. The program was adapted to the VIC-20 by redefining the VIA and screen addresses.

The signal from the cassette tape adapter is input on pins D and 4 of the cassette I/O connector. This goes directly to the CA1 pin of VIA #2. (*Note:* VIA is short for Versatile Interface Adapter and the VIC-20 contains two of them. Each VIA contains two programmable 8-bit ports and two control lines per port. In addition, each VIA contains two 16-bit timer/counters and one shift register. See reference 2 for more details on the VIC-20 and VIA operation.) The

***Listing 1:* Duty Cycle Monitor for VIC-20**

```
5 PRINT""
10 PRINT"CASSETTE RECORDER VOL"
15 PRINT"CONTROL ADJUSTMENT PGM"
20 PRINT"ADJUST VOLUME SO THAT"
25 PRINT"BOTH '+' SYMBOLS LINE"
30 PRINT"UP DURING THE PURE"
35 PRINT"'SYNC' TONE AT THE"
40 PRINT"BEGINNING OF THE TAPE"
80 REM --------------------
90 A=832
100 READ N:FOR M=0 TO N-1:READ H$
105 HH=ASC(LEFT$(H$,1))-48
110 IF HH>9 THEN HH=HH-7
115 HL=ASC(RIGHT$(H$,1))-48
120 IF HL>9 THEN HL=HL-7
125 H=HL+HH*16
130 POKE A+M,H:NEXT M
135 PRINT:PRINT"<HIT ANY KEY TO START>"
140 GET A$:IF A$="" THEN 140
145 L$="    [--------------]"
150 PRINT"<HIT ANY KEY TO STOP>"
155 PRINT""L$
160 FOR I=38576TO38641:POKEI,0:NEXTI
165 POKE251,0:POKE252,0
170 SYS A:GET A$:IF A$="" THEN 170
180 PRINT:PRINT:PRINT"NOW LOAD THE PROGRAM"
190 END
299 REM --------------------
300 DATA 115
310 DATA 20,66,03,20,7D,03,20,5D
320 DATA 03,A2,00,20,88,03,20,5D
330 DATA 03,20,7D,03,20,66,03,A2
340 DATA 01,20,88,03,60,A9,01,0D
350 DATA 2C,91,20,6F,03,60,A9,FE
360 DATA 2D,2C,91,20,6F,03,60,8D
370 DATA 2C,91,AD,21,91,A9,02,2C
380 DATA 2D,91,F0,FB,60,A9,FF,8D
390 DATA 18,91,A9,00,8D,19,91,60
400 DATA A9,00,AC,19,91,D0,0A,38
410 DATA A9,FF,ED,18,91,4A,4A,4A
420 DATA 4A,48,A9,B3,CA,E8,F0,02
430 DATA A9,DF,85,D1,B4,FB,A9,20
440 DATA 91,D1,68,A8,94,FB,A9,2B
450 DATA 91,D1,60
```

Listing 2

```
DUTY CYCLE MONITOR FOR VIC-20
                * VIC-20 CASSETTE TAPE LEVEL ADJUST UTILITY
                *
                * BY BOB KOVACS - 16 MAR 82
                * 41 RALPH ROAD, WEST ORANGE NJ 07052
                *
                *
                * THIS ROUTINE DISPLAYS THE DURATION
                * OF + AND - CYCLES OF THE CASSETTE
                * TAPE WAVEFORM INPUT ON CA1 OF VIA2
                *---------------------------------
                * USE CASSETTE FILE BUFFER SPACE
                *
                        .OR $0340    832 DECIMAL
                        .TA $0800
                *
                *       .LISTOFF
                *---------------------------------
                *
00D1-           LINE    .EQ $D1,D2   START ADDRESS OF CURRENT
                                     SCREEN LINE
00FB-           TMP     .EQ $FB      PLOT INDEX
                *
1EB3-           LINE9   .EQ $1EB3    START ADDRESS OF LINE #9 + 3
1EDF-           LINE11 .EQ $1EDF     START ADDRESS OF LINE #11 + 3
                *
9110-           VIA1    .EQ $9110    USER VIA BASE ADDRESS
9120-           VIA2    .EQ $9120    INTERNAL VIA BASE ADDRESS
                *
                * 6522 REGISTER DEFINITIONS
                *
0000-           INOUT.B .EQ $00      PORT B INPUT/OUTPUT REGISTER
0001-           INOUTH.A .EQ $01     PORT A INPUT/OUTPUT
                                     REG W/HANDSHAKE
```

(Continued)

Listing 2 *(Continued)*

```
0002-               DDIR.B .EQ $02      PORT B DATA DIRECTION REGISTER
0003-               DDIR.A .EQ $03      PORT A DATA DIRECTION REGISTER
0004-               T1C.LO .EQ $04      TIMER 1 COUNTER LOBYTE
0005-               T2C.HI .EQ $05      TIMER 1 COUNTER HIBYTE
0006-               T1.LO  .EQ $06      TIMER 1 LATCH LOBYTE
0007-               T1.HI  .EQ $07      TIMER 1 LATCH HIBYTE
0008-               T2.LO  .EQ $08      TIMER 2 LOBYTE
0009-               T2.HI  .EQ $09      TIMER 2 HIBYTE
000A-               SHIFT  .EQ $0A      SERIAL I/O SHIFT REGISTER
000B-               AUXCON .EQ $0B      AUXILIARY CONTROL REGISTER
000C-               PERCON .EQ $0C      PERIPHERAL CONTROL REGISTER
000D-               INTFLG .EQ $0D      INTERRUPT FLAG REGISTER
000E-               INTEN  .EQ $0E      INTERRUPT ENABLE REGISTER
000F-               INOUT.A .EQ $0F     PORT A INPUT/OUTPUT REGISTER
                    *-------------------------------
                    *
0340- 20 66 03      START   JSR NEG     WAIT FOR NEG CA1
0343- 20 7D 03              JSR SETT2   START TIMER
0346- 20 5D 03              JSR POS     WAIT FOR POS CA1
0349- A2 00                 LDX #$00    INIT LINE INDEX
034B- 20 88 03              JSR PLOT    DISPLAY TIME OF NEG CYCLE
                    *
034E- 20 5D 03              JSR POS     WAIT FOR POS CA1
0351- 20 7D 03              JSR SETT2   START TIMER
0354- 20 66 03              JSR NEG     WAIT FOR NEG CA1
0357- A2 01                 LDX #$01    INIT LINE INDEX
0359- 20 88 03              JSR PLOT    DISPLAY TIME OF POS CYCLE
                    *
035C- 60                    RTS         RETURN BACK TO BASIC
                    *-------------------------------
                    * WAIT FOR POS TRANSITION ON CA1
                    *
035D- A9 01         POS     LDA #$01
035F- 0D 2C 91              ORA PERCON+VIA2 SET LOBIT
0362- 20 6F 03              JSR TRAN
0365- 60                    RTS
                    *-------------------------------
                    * WAIT FOR NEG TRANSITION ON CA1
                    *
0366- A9 FE         NEG     LDA #$FE
0368- 2D 2C 91              AND PERCON+VIA2 CLR LOBIT
036B- 20 6F 03              JSR TRAN
036E- 60                    RTS
                    *-------------------------------
                    * WAIT FOR ANY TRANSITION ON CA1
                    *
036F- 8D 2C 91      TRAN    STA PERCON+VIA2 SETUP CA1 CONTROL
0372- AD 21 91              LDA INOUTH.A+VIA2 CLR CA1 INTERRUPT FLAG
0375- A9 02                 LDA #$02    CA1 INTERUPT MASK
0377- 2C 2D 91      .10     BIT INTFLG+VIA2 TEST FOR CA1 TRANSITION
037A- F0 FB                 BEQ .10     LOOP UNTIL FOUND
037C- 60                    RTS
                    *-------------------------------
                    * INTITIALIZE & START T2 TIMER
                    *
037D- A9 FF         SETT2   LDA #$FF    INIT LOBYTE
037F- 8D 18 91              STA T2.LO+VIA1
0382- A9 00                 LDA #$00    INIT HIBYTE &
0384- 8D 19 91              STA T2.HI+VIA1  START COUNTDOWN
0387- 60                    RTS
                    *-------------------------------
                    * READ TIMER & DISPLAY COMPLEMENT
                    *
0388- A9 00         PLOT    LDA #$00    CHECK TIMER FOR UNDERFLOW
038A- AC 19 91              LDY T2.HI+VIA1
038D- D0 0A                 BNE .05     BRANCH IF NG
                    *
038F- 38                    SEC         SETUP FOR SUBTRACTION
0390- A9 FF                 LDA #$FF    DETERMINE PULSE DURATION
0392- ED 18 91              SBC T2.LO+VIA1 IN CPU CYCLES
0395- 4A                    LSR         DIVIDE BY 4
0396- 4A                    LSR         TO LIMIT RESULT
0397- 4A                    LSR         BETWEEN 0 & 16
0398- 4A                    LSR
0399- 48            .05     PHA
039A- A9 B3                 LDA #LINE9  LOAD SCREEN LINE OFFSET
039C- CA                    DEX
039D- E8                    INX         IS X=0 ?
039E- F0 02                 BEQ .10
03A0- A9 DF                 LDA #LINE11 ALTERNATE OFFSET
03A2- 85 D1         .10     STA LINE    SET LINE POINTER
03A4- B4 FB                 LDY TMP,X   PREVIOUS PLOT INDEX
03A6- A9 20                 LDA #$20    SPACE
03A8- 91 D1                 STA (LINE),Y CLEAR OLD PLOT
03AA- 68                    PLA
03AB- A8                    TAY
03AC- 94 FB                 STY TMP,X   SAVE NEW PLOT INDEX
03AE- A9 2B                 LDA #$2B    '+'

DUTY CYCLE MONITOR FOR VIC-20
03B0- 91 D1                 STA (LINE),Y DISPLAY TO SCREEN
03B2- 60                    RTS
                    *-------------------------------
```

VIA can be programmed to detect either a positive or negative transition at the CA1 pin *via* the Peripheral Control Register. (This is just one of sixteen registers contained in each VIA.)

The approach is fairly straightforward. First set the VIA to detect a negative transition of CA1, and wait for that transition to occur. Then immediately start one of the VIA timers that counts down at the basic CPU clock rate. While the timer is counting, set the VIA to detect a positive transition of CA1, and wait for the transition. When it occurs, read the contents of the timer. Subtracting this value from the initial one results in the duration (in CPU cycle time units) of the negative portion of the input waveform. Since the ideal sync waveform is a square wave with a frequency of about 3 KHz (3000 cycles per second), its half-cycle duration is about 167 microseconds. For a CPU clock speed of 1 MHz this is equivalent to 167 timer units.

Allowing a measurement range of 0 to 255 seems reasonable and limits the arithmetic to the low byte of the 16-bit timer value. A graphic display is more desirable than a numeric one, but the VIC's display is limited to 22 columns per line. Although higher resolution could have been obtained by defining special plot characters through screen bit mapping techniques, I found that a lo-res plot was adequate. The timer measurement was divided by 16 to limit the range from 0 to 15. The "+" symbol was plotted on the screen by storing it directly in screen memory, using the time duration as an offset.

Next, this entire operation was repeated for the positive portion of the input waveform. This measurement is plotted below the previous one. When the plot symbols line up, both cycles have the same time duration.

Apparently the VIC is occasionally interrupted by the other VIA timers to perform routine housekeeping functions. No attempt was made to disable this activity and this sometimes results in a scrambled plot. A check is made on the timer high byte to help clean up this interference. Since the timer is initialized to 255 at the start of the countdown and a duration of 176 is normally expected, if the high byte is found to be nonzero, it is likely that this measurement was corrupted and the reults invalid. An invalid measurement is indicated by locating the plot symbol at the leftmost position.

The BASIC Program

The BASIC program shown in listing 1 includes the machine-language routine just described. Of the various methods considered to combine machine language with BASIC, I decided that a simplified approach was less prone to error, although less memory efficient. The first hurdle to overcome was a conflict in number bases. BASIC requires that numbers be in decimal, whereas hexadecimal is more natural for machine code. As can be seen from the listing, the machine-language routine is entered as a hexadecimal string and lines 105 through 125 perform a conversion to decimal. The resultant value is then POKEd into the RAM space allocated to the cassette file buffer. Since no file data is input during this measurement, this space remains unused and is a convenient place to put the machine-language program. (Note that it takes about four seconds to convert and store 115 bytes.)

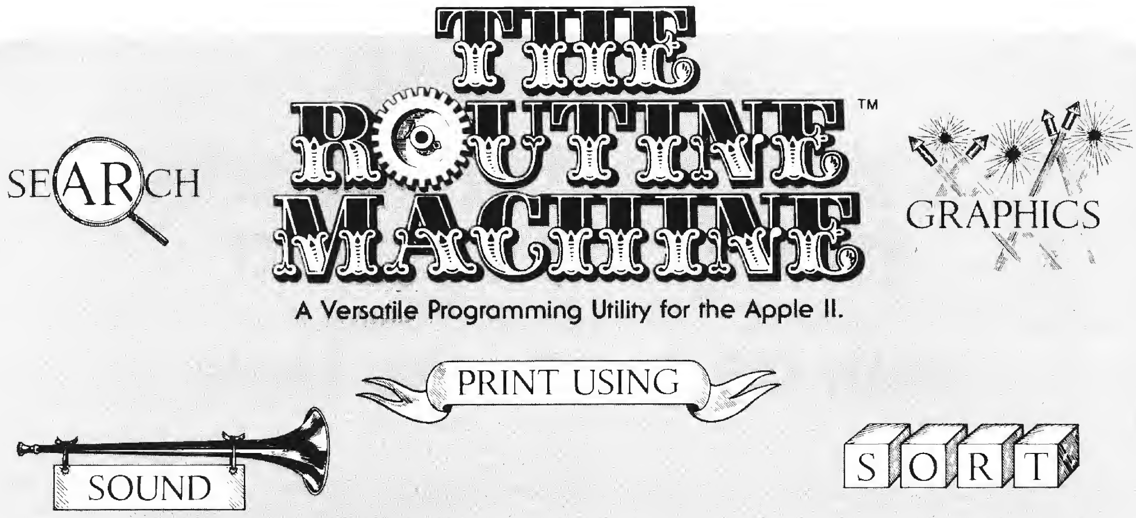
Line 145 defines a plotting scale with time increasing toward the right with a scale factor of about 16 microseconds per column. Line 160 sets the screen color from white to black for those lines (9, 10, and 11) that will contain plot characters. Line 165 initializes two temporary page-zero locations which hold the location of the previous plot position. Before plotting the new point the old plot symbol must be erased by writing a space over it. Finally, line 170 calls the machine-language routine with the SYS command. After a pair of points are plotted, control returns to that line where the keyboard is tested for input. Hitting any key exits the program, otherwise it loops back to plot another pair of points. Remember that control returns to BASIC only if a signal is detected on the cassette input line (but you can use RESTORE to quit at any time).

Just a final word on the printout shown in listing 1. My Epson MX-80 printer does not print those special VIC-20 display control characters which show up as graphics symbols. Thus the inverse heart symbol used to indicate 'clear screen' is not printed within the quote marks on lines 5 and 150. Similarly the nine 'cursor down' inverse Q symbols did not get printed in line 155. Make sure you include them when you type in the program. Lines 140 and 170, however, are just null strings with nothing between the quote marks.

References

1. "Add a Cassette Interface to Your VIC-20," *BYTE*, March 1982.
2. "VIC-20 Programmer's Reference Guide," Commodore Business Machines, Inc.

Bob Kovacs has been captivated by microcomputers since the Apple II made its debut four years ago. He has recently been unraveling some of the mysteries of the VIC-20 and is actively involved with several microcomputer hardware and software projects. He may be contacted at 41 Ralph Road, West Orange, NJ 07052.


SEARCH
THE ROUTINE MACHINE™
GRAPHICS
A Versatile Programming Utility for the Apple II.
PRINT USING
SOUND
SORT

Interfacing the Color Computer

by John Steiner

Circuits to interface the Color Computer to an RS-232 port and a motor control relay are presented. A Morse Code send/receive program is included as a demonstration.

Morse Code
requires:
TRS-80 C
Interface hardware
Code-send hardware

One of my goals was to write a program that would send machine-quality Morse code, but two good friends beat me to it. Arlin Karger and Ken Christiansen spent many hours learning how to interface the computer to other equipment. The techniques discussed here will assist you in your particular application.

Interfacing to the Outside World

The Color Computer has three output ports built into its system — the motor control relay, the RS-232 port, and the cassette port. The program listed here can use two of them. The motor control relay is used to key a transmitter. The REM statement in line 35 outlines the changes that must be made to the program to implement an RS-232 option.

The output ports on the TRS-80C are peripheral interface adapters (PIAs). These versatile ICs look like just another memory location to the processor, while allowing the programmer to use them to input or output data. Since these devices are memory mapped, a simple PEEK will read data from the outside world, while a POKE will write data out. The programmer must initialize the PIA to perform either an input or output function, upon power-up. The BASIC interpreter has done this for us, so using these locations is simple. A POKE 65313,60 will close the cassette motor control relay, allowing the cassette to run if it is in play. POKE 65313,52 turns off this relay. Another output port, the RS-232 data-out line, is controlled by memory location 65312. POKE 65312,0 and POKE 65312,2 change the logic state of the data-out pin on the RS-232 port. After the program description, several interface circuits are shown, which can be used to connect the Color Computer to a transmitter, or almost any external device.

Program Details

This program was inspired by a Morse send-receive program for the model I/III TRS-80 in *QST* magazine. After lamenting that the program would not run on the TRS-80C, Arlin attempted to duplicate its transmit functions. He ran into quite a few problems trying to adapt the program to the Color Computer. This listing barely resembles the original version, and many additions and features have been added that make it a real ham operator's program. However, credit for the algorithm belongs to J.C. Sprott, W9AV, and is gratefully acknowledged.

After Arlin finished work on the program, he found that there were timing and processing problems. The code it sent had a real "banana boat swing." Programming to precision timing in BASIC is a challenge in itself, so Arlin called upon Ken to assist in fine-tuning the program. The program now only lacked a receive function. This was not considered to be a serious handicap, since most Morse code programs have difficulty decoding all but the most precisely sent text. Ken thought it would be nice, however, to add a keyboard routine the operator could use to copy the message as it is being sent. The operator would be able to review the text of the contact at his leisure.

Meanwhile, Arlin was not content to leave the transmit section alone, so he went back to work. First he added a cursor that followed along, sending text behind the type-ahead buffer, then adding three message buffers to be called at the operator's request. These buffers are probably the most useful accessory a code operator can have. Each buffer can store up to 254 characters, so you could store nearly an entire contact in the buffer.

Program Initialization

The program REMarks indicate changes that can be made if you have a 32K machine. Essentially you are able to store a larger receive buffer. You also have two options for interfacing your computer with the transmitter. You may use either the cassette motor relay or the RS-232 interface. Included are a few inexpensive, easily built circuits that perform the interface function. More details on these later.

The program execution begins with a POKE command, which switches the microprocessor into the high speed mode. As a result, internal timing of the machine is increased by a factor of two. One caution is in order here: do not exit this program with the BREAK key. If you do, you will still be in high speed, and tape saves and loads will crash with an error. Press the <$> key to end the program. This will return the computer to normal speed. Or press the RESET button on the right rear of the computer. Another caution: if you have a Color Computer disk system, you will have to unplug it and load this program from cassette or rewrite the timing loops to work in low speed, as the disk system will not support the high-speed POKE. If you attempt to execute the POKE with a disk in the drive, you may lose all information on the disk. Some non-disk Color Computers will not support the high-speed POKE because the PIAs that handle keyboard and other interfacing duties are not fast enough. If, after running this program, the computer locks up, or operates erratically, you will have to remove the POKE commands and rewrite the timing routine. Maximum reliable sending speed will drop to about 20 WPM.

After reserving memory, program control branches to line 760, where memory is reserved, and the code look-up table is entered into memory. Though DIM statements are usually put at the beginning of a program, timing of the sending was erratic until the two array statements were moved closer to the lines associated with the send routine. We're still trying to figure out why. You will be asked to input the speed in words per minute, after which the instructions are printed. Then the dot/dash ratio is optimized in the routine starting at line 450, and the main program routine begins in the receive mode with line 200.

Operation of the Receive Section

A control loop, initiated in lines 210 to 300, gets characters from the keyboard using the INKEY$ function. Lines 230 to 250 check each key entered for the command symbols that allow branching away from the receive section. To switch between transmit and receive, just press the up arrow. To end the program, you must press the dollar sign key. Pressing the <@> key will display the transmit menu and allow you to change speed; transmit; or review, load, and/or send the three transmit buffers.

If the ampersand key (&) is found, control will branch to the display receive buffer routine, so you may review the receive text as desired. Upon entering the transmit mode, the latest receive text is added to the end of the receive buffer. As a result, this breaks the buffer into blocks of text that can be reviewed one at a time. Line 440 contains the subroutine that increments the text block counter as each group of text is being stored, and also increments if the string length reaches 200 characters. You may look at any section of the receive buffer or, by entering < 1000>, return to receive.

Line 260 helps to keep words from being broken up at the right edge of the screen. For the user, the computer becomes an electric typewriter with CRT readout.

The Transmit Section

When you are ready to transmit, you have two choices: you can press the up arrow to go directly to transmit, or press the <@> key to display the transmit menu. The transmit section begins at line 1100, where the screen clears and TX appears in the upper left-hand corner. You may begin typing, and the transmit cursor will follow

Listing 1: Morse Code Send-Receive

```
5 REM THIS CW SENDING PROGRAM  WAS WRITTEN FOR THE TR680 COLOR COMPUTER BY ARLIN
 KARGER,WDOHXQ AND THE RECEIVE,TYPING FUNCTION WAS ADDED BY KENNETH CHRISTIAN- S
EN,WOCZ.THE IDEA WAS INSPIRED  BY AN ARTICLE IN JULY 81 QST BY W9AV.
15 REM QUESTIONS MAY BE DIRECT- ED TO WDOHXQ MOORHEAD,MINN OR   WOCZ FARGO, N.D.
25 REM FOR 32K CHANGE LINE 60 TO CLEAR 18000; CHANGE LINE 760 TO DIM RA$(800)
35 REM FOR RS232 OUTPUT CHANGE POKES IN LINES 990 AND 1210 TO POKE 65312,0 AND L
INES 1020 AND 1240 TO POKE 65312,2
40 POKE65495,0
50 PCLEAR1
60 CLEAR5000
70 GOTO750
80 RX=1
90 CLS:PRINT@198,"<ENTER> SPEED(WPM)";:INPUT S
100 GOSUB630
110 SS=800/S-19
120 CLS:PRINT@10,"INSTRUCTIONS"
130 PRINT"PRESS <^> TO TRANSMIT":PRINT
140 PRINT"PRESS <^> TO RETURN TO RECEIVE":PRINT
150 PRINT"PRESS <SHIFT AND &> TO REVIEW   RECEIVE PART OF QSO":PRINT
160 PRINT"PRESS <@> FOR SPECIAL TRANSMIT  FUNCTIONS":PRINT
170 PRINT"PRESS <SHIFT AND $> TO END      PROGRAM":PRINT:PRINT
180 INPUT"PRESS <ENTER> TO CONTINUE";RR
190 GOSUB450
200 CLS:PRINT"RECEIVE"
210 RA$=INKEY$
220 IF RA$=""THEN210
230 IF RA$="^"GOSUB440:GOTO1100
240 IF RA$="$"GOTO1330
250 IF RA$="@"THEN800
260 IF POS(0)>22THEN IF RA$=CHR$(32)THEN RA$=CHR$(13)
270 PRINT RA$;
280 IF RA$="&"THEN310
290 IF LEN(RA$(RX))<200THEN RA$(RX)=RA$(RX)+RA$ ELSE GOSUB440
300 GOTO210
310 FOR RY=1TORX-1
320 PRINT RY"--"RA$(RY)
330 NEXT RY
340 INPUT"PRESS<ENTER> TO CONTINUE";RR
350 CLS:PRINT@67,"NUMBER OF SEGMENT OF QSO"
360 PRINT@168,"TO BE REVIEWED"
370 PRINT@257,"1000 TO RETURN TO MAIN PROGRAM"
380 INPUT RS
390 IF RS=1000GOTO200
400 IF RS>RX-1 OR RS<1THEN380
410 CLS:PRINT RA$(RS)
420 INPUT"PRESS <ENTER> TO CONTINUE";RR
430 GOTO350
440 RX=RX+1:RETURN
450 D=-30
460 F=.6
470 IF S>7THEND=-20:F=.6
480 IF S>8THEND=-10:F=.6
490 IF S>11THEND=-1:F=.7
500 IF S>14THEND=1:F=.8
510 IF S>16THEND=2:F=.9
520 IF S>18THEND=0:F=1
530 IF S>22THEND=0:F=1.2
540 IF S>24THEND=10:F=1.4
550 IF S>25THEND=5
560 IF S>26THEND=5:F=1.7
570 IF S>28THEND=20:F=2
580 IF S>29THEND=5
590 IF S>30THENF=2.4
600 IF S>32THEND=5:F=2.8
610 IF S>34THEND=5:F=3.5
620 RETURN
630 IF S>30THEN90
640 IF S=30THENS=35
650 IF S=29THENS=33
660 IF S=28THENS=30
670 IF S=27THENS=28
680 IF S=26THENS=27
690 IF S=25THENS=26
700 IF S=24THENS=25
710 IF S<24THENS=S
720 IF S<5THENS=5
730 RETURN
740 GOTO 750
750 CLS:PRINT@200,"PLEASE STAND BY"
760 DIM RA$(200)
770 DIM P(47,6)
780 FOR Q=1TO47:FOR U=1TO6:READ P(Q,U):NEXT U,Q
790 GOTO80
800 PRINT:PRINT:PRINT"0= SEND FROM KEYBOARD","1= SEND BUFFER #1","2= SEND BUFFER
 #2","3= SEND BUFFER #3","4= STORE BUFFERS","5= CHANGE SPEED",,"6= REVIEW BUFFER
S","7= RECEIVE":PRINT
810 INPUT"WHICH ACTION?(1-7)";WA:CLS
820 IF WA=0THEN1100
830 IF WA=1THEN B$=MA$:IF MA$=""THEN800:GOTO940
840 IF WA=2THEN B$=MB$:IF MB$=""THEN800:GOTO940
850 IF WA=3THEN B$=MC$:IF MC$=""THEN800:GOTO940
860 IF WA=4THEN1350
870 IF WA=5THEN90
880 IF WA=6THEN1530
890 IF WA=7THEN200
900 IF WA>7THEN800
910 DATA 5,5,1,1,5,5,1,5,1,5,1,0,1,5,1,5,1,5,5,1,1,5,1,0,5,5,5,5,5,0,1,5,5,5,5,0
,1,1,5,5,5,0,1,1,1,5,5,0,1,1,1,1,5,0,1,1,1,1,1,0,5,1,1,1,1,0,5,5,1,1,1,0,5,5,5,1
,1,0,5,5,5,5,1,0,5,5,5,1,1,1,5,1,5,1,5,1,1,5,1,1,1,0,5,1,1,1,5,0
```

(Continued)

Listing 1 *(Continued)*

```
920 DATA 1,1,1,5,1,5,1,1,5,5,1,1,0,0,0,0,0,0,1,5,0,0,0,0,5,1,1,1,0,0,5,1,5,1,0,0
,5,1,1,0,0,0,1,0,0,0,0,0,1,1,5,1,0,0,5,5,1,0,0,0,1,1,1,1,0,0,1,1,0,0,0,0,1,5,5,5
,0,0,5,1,5,0,0,0,1,5,1,1,0,0,5,5,0,0,0,0,5,1,0,0,0,0,5,5,5,0,0,0,1,5,5,1,0,0
930 DATA 5,5,1,5,0,0,1,5,1,0,0,0,1,1,1,0,0,0,5,0,0,0,0,0,1,1,5,0,0,0,1,1,1,5,0,0
,1,5,5,0,0,0,5,1,1,5,0,0,5,1,5,5,0,0,5,5,1,1,0,0
940 X=0
950 X=X+1:V$=MID$(B$,X,1):IF V$="@"THEN1100
960 Q=ASC(V$)-43
970 IF Q<1 OR Q>47 THEN PRINT " ";:FOR U=1 TO 16*SS/5:NEXT:GOTO 1060 ELSE PRINT
V$;
980 FOR T=1TO10:NEXT
990 FOR U=1TO 6:IF P(Q,U)=0 THEN GOTO 1060 ELSE POKE 65313,60
1000 FOR Y=D TO F*(SS*P(Q,U)):NEXT
1010 FOR T=1TO10:NEXT
1020 POKE 65313, 52
1030 FOR Y=2 TO SS:NEXT
1040 FOR T=1TO10:NEXT
1050 NEXT U
1060 FOR U=6 TO 2*SS:NEXT
1070 FOR T=1TO10:NEXT
1080 G$=INKEY$:IF G$="@"THEN1100
1090 GOTO 950
1100 CLS:PRINT "TX":B$="":X=0:V$=""
1110 CS$=CHR$(143+112)
1120 B$=MID$(B$,2)
1130 Z$=V$+CS$+MID$(B$,2)
1140 PRINT@X,Z$;
1150 E$=INKEY$:B$=B$+E$:PRINT E$;
1160 V$=MID$(B$,1,1):IF V$="" THEN 1150
1170 IF V$="@" THEN 800
1180 IF V$="^" THEN 200
1190 Q= ASC(V$)-43
1200 IF Q<1OR Q>47 THEN PRINT"";: FOR U=1 TO 4*SS/5:E$=INKEY$:B$=B$+E$:PRINTE$;:
NEXT:GOTO 1290
1210 FOR U=1 TO 6: IF P(Q,U)=0 THEN GOTO 1290 ELSE POKE 65313, 60
1220 FOR Y=D TO F*(SS*P(Q,U)):NEXT
1230 E$=INKEY$:B$=B$+E$:PRINT E$;
1240 POKE 65313, 52
1250 E$=INKEY$:B$=B$+E$:PRINT E$;
1260 FOR Y=2 TO SS:NEXT
1270 E$=INKEY$:B$=B$+E$:PRINT E$;
1280 NEXT U
1290 FOR U= 6 TO 2*SS:NEXT
1300 E$=INKEY$:B$=B$+E$:PRINT E$;
1310 X=X+1:IF X=415 THEN X=0:CLS
1320 GOTO 1120
1330 POKE 65494,0
1340 END
1350 PRINT"ENTER BUFFER #1 (Y/N)"
1360 YN$=INKEY$:IF YN$=""THEN1360
1370 IF YN$="Y" THEN 1390
1380 IF YN$<>"Y"THEN1400
1390 CLS:LINE INPUT"ENTER BUFFER #1  ";MA$:MA$=MA$+"@"
1400 PRINT"ENTER BUFFER #2 (Y/N)"
1410 YN$=INKEY$
1420 IF YN$=""THEN1410
1430 IF YN$="Y"THEN1450
1440 IF YN$<>"Y"THEN1460
1450 LINE INPUT"ENTER BUFFER #2  ";MB$:MB$=MB$+"@"
1460 PRINT"ENTER BUFFER #3 (Y/N)"
1470 YN$=INKEY$
1480 IF YN$=""THEN1470
1490 IF YN$="Y"THEN1510
1500 IF YN$<>"Y"THEN1520
1510 LINE INPUT"ENTER BUFFER #3  ";MC$:MC$=MC$+"@"
1520 GOTO 800
1530 PRINT "BUFFER #1 =",,MA$:INPUT"PRESS <ENTER>";RR:PRINT:PRINT "BUFFER #2 =",
,MB$:INPUT"PRESS <ENTER>";RR:PRINT:PRINT "BUFFER #3 =",,MC$:INPUT "PRESS <ENTER>
";RR:GOTO800
```

***Table 1:* Parts List**

Component	Radio Shack Part Number
Q1 NPN	276-2016
Q1 PNP	276-2023
D1, D2	275-1101
RL1	275-004
R1	1 K ½ watt
R2	10 K ½ watt
RS-232 Plug	26-3020 four-pin DIN cable that Radio Shack provides for the Color Computer. Cut it in two pieces, and save the remainder for another project.

Mini Phone Jack — 2 conductor 1/8 inch to connect to motor control plug on cassette cable.

Miscellaneous hardware, etc., to connect to your transmitter.

along behind you sending what has been entered from the keyboard. Again, the INKEY$ function is used to get keys from the keyboard. The keyboard is checked between each element of each character being sent. This gives the operator plenty of access to the keyboard, but you must develop a consistent typing stroke. Typing speed will be affected by code speed. You will have to slow your typing, and use a consistent entry speed, or you may lose characters.

Each character is converted to its ASCII value, minus 43, in line 1190, where it is compared to the look-up table array. Note that the code is actually stored in this array. Initial values are one for a "dit," and five for a "dah," with correction applied after the speed is selected.

Don't use the backspace key or try to type too far ahead of the text being sent. Either of these actions will cause sending problems. Try to keep only a line or so ahead, although no problems should begin until you get more than 255 characters ahead. As characters are being sent directly from the buffer string (B$), a backspace could branch to a subroutine that eliminates the last character of B$. This, however, will affect the timing, so modifications in the send routine will result in modifications to the statements in lines 450 to 730.

To return to receive, just press the up arrow. If you wish to use the transmit buffers, press the <@> key, which will transfer control to line 800, where the Transmit menu will be displayed. The menu allows the following options: send from the keyboard; send message 1, 2, or 3; store messages; change speed; review messages; or, return to receive.

Choosing the store message option will send program control to line 1350. The "ENTER MESSAGE #1 (Y/N)" prompt will appear. Enter a Y and you may enter a message, otherwise you will be asked if you want to enter the second message. After stepping through each message, control returns to the transmit menu. The messages are stored with an < @ > symbol at the end, which will send control immediately to the menu so you may choose another message or return to transmit or receive.

Interface Circuits

This section describes five circuits that allow you to interface the computer to the transmitter, or any device that needs a logic state change to perform a desired function. Do not key a

Figure 1

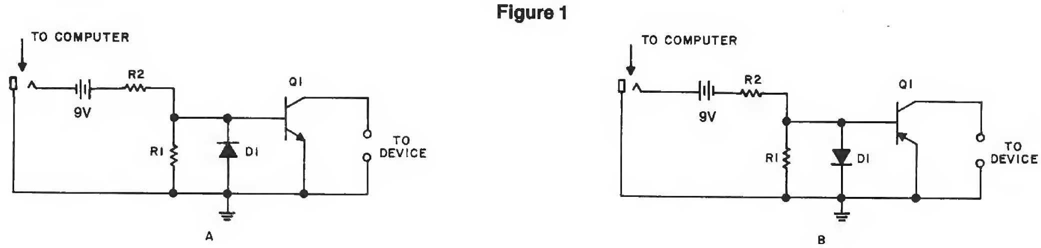
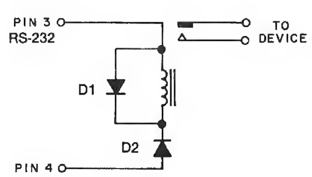


Figure 2

Figure 3



transmitter, or other high current device, directly from the motor control relay. It is not built for that kind of demand.

Figure 1 contains two circuits — either can be used to interface the computer. Figure 1A is for positive-going logic, while 1B is for transmitters with grid-block keying or other negative-going bias circuits. Figure 2 contains two circuits that can be used to connect to the RS-232 interface. Again, figure 2A is for positive logic, and 2B is for negative bias circuits. If you have grid-block keying, and you intend to use the RS-232 jack, you must reverse the data in the POKE statements from what is stated in the REM in line 35. In other words, lines 990 and 1210 must contain POKE 65312,2 and 1020, and line 1240 uses POKE 65312,0. Also, if you have grid-block keying, you must be careful not to turn on the transmitter until the program is running and ready to send. This is because the normal logic level of the RS-232 will key the transmitter on until the program initiates and shuts it off. Figure 3 contains another RS-232 circuit that uses only a relay and a couple of diodes. The advantage of using the RS-232 is that no external voltage source is required.

All parts are available from Radio Shack, and their part numbers are listed in table 1. All circuits could be easily wired onto perfboard, or mounted on a PC board.

The program listing is quite long, and if you decide not to type it in, a cassette version is available. Just send $5.00 to:

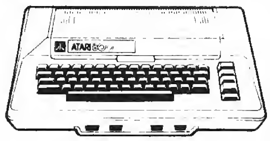
Arlin Karger
2214 South Eleventh St.
Moorhead, MN 56560

We hope this article will inspire you to develop techniques that let you interface your computer to the world around it. The applications are limited only by the imagination.

John Steiner is an electronics instructor in the Fargo, ND school system. His hobbies include programming, amateur radio, and writing. He has written articles for several publications, and is at present completing a book on electronics. John's computer system includes a 32K TRS-80C with Radio Shack disk system, and an Epson MX-80 printer.

MICRO™

ATARI



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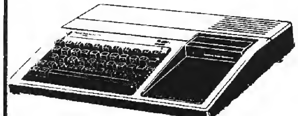

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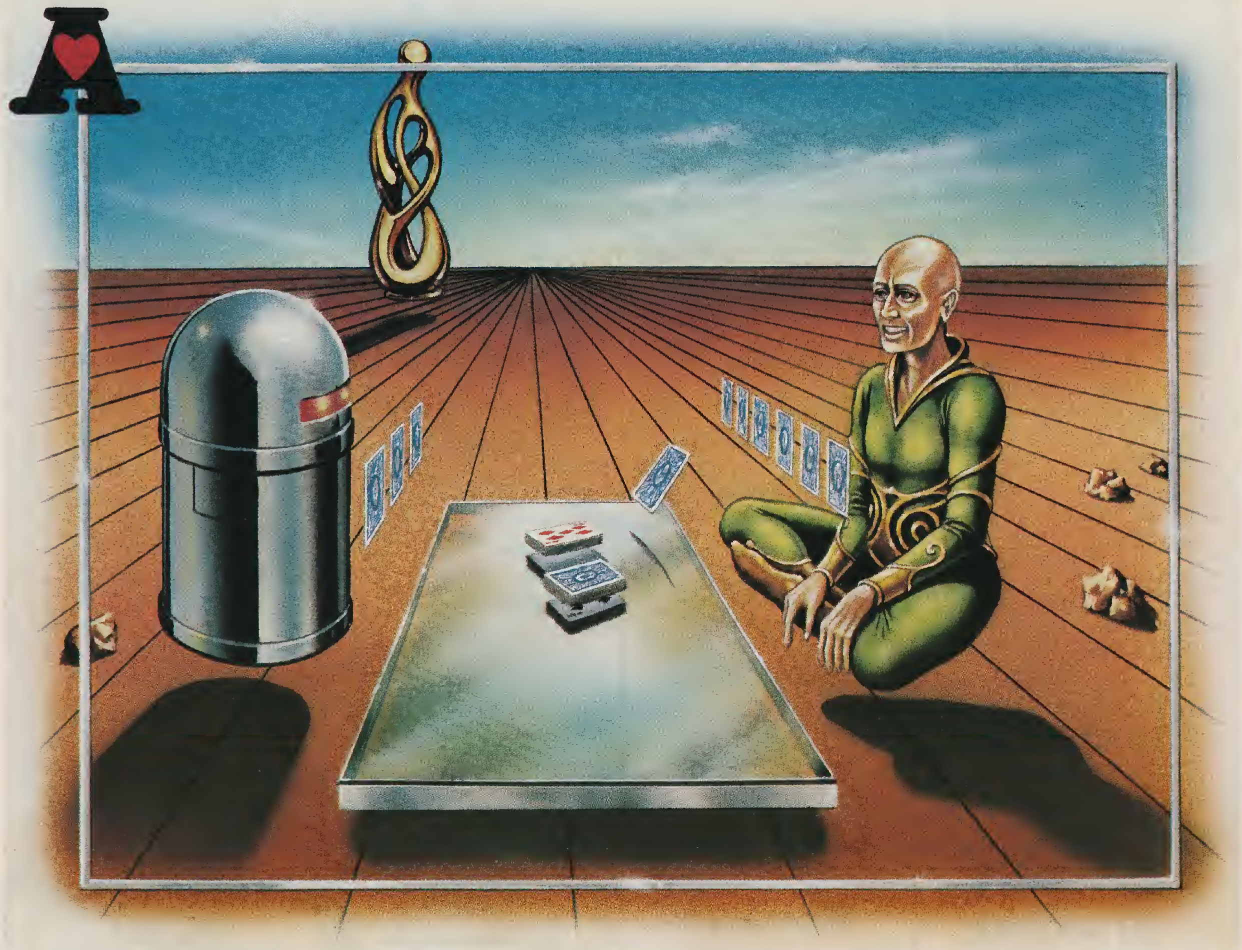


MICRO™

Reviews in Brief

Product Name: **Disassembler 6809**
Equip. req'd: TRS-80C Color Computer with 16K memory
Price: $19.95
Manufacturer: Soft Sector Marketing
6250 Middlebelt
Garden City, MI 48135

Description: This product is a disassembler written in BASIC and distributed in Color Computer cassette format. Besides the intended disassembly function, which basically goes to the screen, it has a printer output and a rather nice subroutine trace function. It also has a "Zap" display mode which zips through code and displays three columns of two-byte values, without regard for opcodes, etc; in other words, a screen dump. The subroutine mode allows the user to stop the current disassembly pass and trace down a subroutine, with nesting to 20 levels. At the end of a side excursion, the program will return to the same page of disassembly it was on when diverted.

Pluses: Low cost and reasonable speed of operation, thus greatly expanding the capability of the computer's BASIC to include assembly-language experimentation. Easy to use, with short learning curve. Although the program is not able to directly handle data tables, it flags inappropriate values with "bad opcode" and this should alert the user to the possibility of the presence of a data table at the address being disassembled. The experienced 6809 programmer will be able to define quickly the data table, and the disassembler quickly "syncs up" with valid code following the data.

Minuses: No problems noted except that for instructions of the form LEAX LABEL,PCR, the output fails to specify the ,PCR mode for instructions using 16-bit offset (8-bit offset instructions are correctly specified). This is a relatively minor bug, and does no harm as long as the user is aware of it.

Skill level required: In general, a user would need to be quite familiar with the computer's assembly language before being able to derive a significant amount of information from any disassembler.

Reviewer: Ralph Tenny

Product Name: **Compuvoice Synthesizer**
Equip. req'd: TRS-80 Color Computer, 16K or 32K with Extended BASIC
Price: $44.95
Manufacturer: Spectral Associates
141 Harvard Avenue
Tacoma, WA 98466

Description: The *Compuvoice Synthesizer* is a completely software-based phoneme speech generator for the TRS-80C. It is a machine-language routine that resides in high memory. Access to the synthesizer is *via* USR calls. The phonemes are generated in software and are sent to the audio circuit in the monitor. Using the synthesizer is not difficult. Strings are defined that contain special phoneme symbols. These strings are the arguments in the USR call. For example, X$="/AAYT/":A$=USR0(X$) is all the code that is required for the computer to pronouce the word "eight". You can redefine the strings and pronounce new words and phrases. String length is limited only by BASIC's 255-character limit.

Pluses: The routine is easy to load and execute. The phonemes are easily defined and generated. The process of learning to operate the synthesizer teaches the programmer the techniques of artificial speech generation. Though based on international language, the phonemes have been changed to single key characters for easy entry. The synthesizer needs no hardware modifications and uses only 8336 bytes.

Minuses: The actual speech is difficult to understand at best. I spent a lot of time trying to make it say certain phrases and was not often successful in having an interested observer understand what it was saying. Certain phrases are easier to understand than others. Even the demonstration program provided, which speaks the numbers from one to nine, had numbers that were difficult to understand.

Documentation: An excellent five-page manual explains the operation of the program, and loading and use in BASIC programs. Also included are instructions on creating speech using phoneme synthesis. Within only a few minutes, I had created a program that allowed me to enter and edit strings to be spoken.

Skill level required: Knowledge of BASIC programming, especially string handling techniques. No previous knowledge of speech synthesis is required.

Reviewer: John Steiner

Product Name: **Dot Matrix Serial Impact Printer Model 8510 Prowriter**
Equip. req'd: Any computer with either parallel or serial interface
Price: $740.00
Manufacturer: C. Itoh Electronics, Inc.
5301 Beethoven Street
Los Angeles, CA 90066

Description: A dot matrix printer using a 7×9 matrix for alphabetic characters; an 8×8 matrix for graphics. Both parallel and serial (to 9600 baud) interfaces are standard. Input buffer holds 1.5K bytes. Printing speed is 100 CPS or 44 LPM (80-character lines). Both sprocket and friction feed are standard. Maximum paper width 9.5", print line 8". Four type faces are standard: pica, elite, compressed, and proportional (10, 12, 17, and 14 cpi). All are available in boldface; all except proportional in elongated

Reviews in Brief *(continued)*

(double-width). Bit-image graphics standard: 8 dots in matrix addressable by bit.

Pluses: Well-formed characters, true lower-case descenders, German, Swedish, and some Japanese characters. Extensive choice of options — both hardware and software — including 16 horizontal tabs, vertical tabs to any line, line-feed selectable in 1/144-inch increments.

Minuses: None serious. Print quality not quite equal to a daisy wheel printer although excellent for dot matrix. A wider carriage and higher printing speeds would be convenient.

Documentation: "Preliminary" 60-page manual. Complete and well-written. The few typographical errors do not appear at critical points.

Skill level required: Minimal, if the computer has a suitable output port. Considerable programming ability needed to take full advantage of all options.

Reviewer: Rolf B. Johannesen

Product Name:	**"SLIM" Single Board Computer p/n 81-260**
Equip. req'd:	Normal assembly tools for kit; depends upon application with assembled and tested version.
Price:	$199.95 - assembled and tested $169.95 - kit $ 39.95 - bare board
Manufacturer:	JOHN BELL Engineering, Inc. P.O. Box 338 Redwood City, CA 94064

Description: "*SLIM*" is an acronym for Single-board Large-scale Integration Microcomputer. It gives more power than a KIM-1 on a 4.5" × 6.5" PC board, but there is no keyboard or display. (An external terminal is used if the JBE 4K monitor ROM is used in the EPROM socket.) Otherwise, the user must furnish a mode of communication. A fully loaded *SLIM* has four 2114 RAM chips, one EPROM socket which may be jumpered for 2716/2516 or 2532 EPROMs, and two 6522 VIAs. Sixteen port lines and four handshake lines from each 6522 are brought to four separate 16-pin sockets, and the industry-standard dual 22-pin edge connector duplicates the KIM expansion connector pinout, except for signals which are unique to KIM. In addition, the address and data lines are fully buffered, and the address decoding scheme from KIM is used. However, since the memory map is significantly different, KIM software would require considerable modification to be used. The circuit design of this product is well done, and relatively minor modifications can be made to effect major changes in board function and capability. The JBE Monitor ($39.95 in a 2532 EPROM) has provision for 110-2400 baud.

Pluses: Good design, standard size, KIM/AIM bus compatibility, and easy expansion. Kit and bare-board users will have little trouble expanding to 8K of read/write memory directly; with additional decoding, 32K or 48K of memory can be added easily with modern memory technology. Similarly, the I/O space and ROM space can be further decoded.

Minuses: Bare-board users may have difficulty finding a 16 MHz crystal (a 7493 TTL counter divides this down to 1 MHz), and should try to purchase the crystal with the board.

Documentation: Skimpy, but adequate for the experienced hacker or engineer.

Skill level required: Even users who buy the assembled and tested unit must have above average experience to apply this product. I found this point to be common with all single-board computer/controller products.

Reviewer: Ralph Tenny

Product Name:	**DTL BASIC**
Equip. req'd:	32K CBM/PET with CBM disk to compile. Some BASIC and adequate memory to hold object file required at run-time. Both require a cassette-port dongle protection device.
Price:	$350; Run-time dongle $50
Manufacturer:	Canadian Micro Distributers 365 Main St. Milton, ONT L9T1P7, Canada

Description: PET BASIC compiler. Takes as input any normal BASIC program file on disk and converts it into a machine-language equivalent. The new file may be loaded and run normally. Uses a 4K run-time module, but compacts source lines. As a result, any program will still fit in memory after being compiled. Compiles 1-2 lines/second. Various listings and information can be printed during compilation. Errors are always shown. At run-time, errors

Reviews in Brief *(continued)*

halt with the usual message and a decimal address. An Error Locate program calculates the matching source line number. The major benefit is speed. Even optimized BASIC programs execute twice as fast as usual, unless slowed by peripherals. Well-structured programs execute at triple speed. DTL BASIC also includes a special integer mode. Programs using only integer variables execute twenty times faster than usual. Pseudo-ops are included for changing some or all variables in existing programs to integers during compilation. A side effect of compilation is that the program becomes difficult to view or change. DTL BASIC also requires a special connector be in place at all times while the compiler or compiled programs run. If a second optional connector is placed on the other casettte port during compilation, the program may later be run with it alone. It comes in standard and custom-keyed versions.

Pluses: Nearly bug-free and very easy to use. Re-compiles with a few keystrokes. Integer converter is helpful, though not automatic. Variables may be seen and changed normally. Compatible with packages that extend BASIC with non-standard syntax. Stopped programs may be continued with SYS, not CONT. The STOP key may be disabled without disturbing the clock. Compiler may be backed up for safety.

Minuses: Major disadvantage is the required run-time dongle. Run-time protection should be a user option. Not able to pass variables between modules of multi-module programs.

Documentation: Quite readable and fairly brief, all in a nice binder. Could use a summary page.

Skill level required: Almost none for first use.

Reviewer: Jim Strasma

Product Name:	**Screen Writer**
Equip. req'd:	Apple II or Apple II Plus (16K memory card optional)
Price:	$125.00
Manufacturer:	On-Line Systems 3675 Mudge Ranch Rd. Coarsegold, CA 93614
Author:	Michael D. Shetter
Copy Protection:	Yes
Language:	6502 Machine Language

Description: A word processor with extensive features at an extremely reasonable price.

Pluses: Provides the owner of a minimal Apple with upper- and lower-case characters and an up to 70-character display with no additional hardware. This is done through the use of the hi-res screen and generation of hi-res characters. By an electrical modification, the shift key can be used as on a standard typewriter (otherwise ESC is used for upper/lower case). The program uses the disk as virtual memory allowing the creation of a single document as large as disk space will permit. If a 16K memory card is present, the additional memory will be used. Has all the usual commands; search and replace, cursor movement, appending files from the disk, a delete/get buffer. Also allows for tab sets. Optionally generates a key click sound through the Apple speaker.

The program consists of two modules: the editor and the runoff (for printing). The user can obtain rough draft printing directly from the editor, but the listing does not contain format control The runoff program contains many of the most desirable print control features affecting margins, paging, text positioning, headings, hyphenation, and type style.

The package also includes a form letter capability for merging two text files, one containing the letter and the other the data base of names, addresses, etc.

A printing spooler routine permits the printing of one document while editing a second. This is accomplished by first creating an output file which contains all of the correctly formatted text. This file is fed to the printer while the user continues to edit a second document.

Minuses: Because the program uses the hi-res screen for display, the insertion of text in the middle of existing text can be annoyingly slow. While there is an input buffer which continues to accept characters as they are printed, it is possible to type faster than the display, so that the incoming text is not visible. After a pause, the display will catch up with the typed input. By moving the cursor to the bottom of the screen, this delay can be avoided since the amount of hi-res memory to be moved is reduced.

Skill level required: After some training, any Apple user can get maximum benefit using this word processor.

Reviewer: David Morganstein

MICRO

Structured Programming in 6502 Assembly Language

by Kim G. Woodward

This discussion of structured programming demonstrates how to use it to improve and simplify your programming methods.

Wouldn't it be nice if someone came along and gave you some good advice about assembly language or BASIC programming? The best advice I've heard lately has been based on the idea of structured programming. What is it, and what can it do for you?

For years the bane of programming has been that the programmer who writes the program is often not the one who will maintain it. Payroll programs are a good example of this problem. For one reason or another, over the life of a piece of software, many modifications may be made. The design, coding, and testing of a program follows the 40-20-40 rule: The design takes 40 percent of the time it takes to finish a program, coding takes 20 percent, and testing takes the last 40 percent. What is not obvious is that over the life cycle of a piece of software, the whole effort to put a program together takes only 20 percent of the time. The other 80 percent is taken up in maintenance (debugging and modification). Structured programming can make this phase much more efficient.

What Is Structured Programming?

Structured programming limits a programmer to a finite set of control structures (elements such as loops, "if" statements, etc.). A program's flowchart is sometimes considered to be the program's logic or set of control structures. A flowchart, however, is one of the most dangerous devices ever conceived by the programming industry. When a design is made, a flowchart is usually drawn up to describe what the program is to do logically. But once the coding is done from that flowchart, the flowchart is usually never updated to reflect any changes made to the program. As a result, a flowchart often does not reflect the actual program that it is supposed to describe. Use of that flowchart may create errors in the program when changes are made.

Structured programming is based on the mathematically-proven Structure Theorem (due in original form to Bohm and Jacopini), which states that any program with one entry and one exit is equivalent to a program that contains as logic structures only the following: sequences of two or more operations, decision (IF a THEN b ELSE c), and repetition of an operation (DOWHILE a). Variations include the case statement, which is a form of "if-then-else;" and the "do-until" loop, which is a variant of the "do-while." A flowchart representation of these constructs is shown in figure 1. The blocks can represent single or multiple statements, or one of the accepted control constructs. Over the years since structured programming was introduced, the software industry has proven over and over that these constructs reduce the complexity of the actual code writing, make the code easier to read, maintain or change, and reduce the programming problem to a number of easily defined modules.

If a programmer confines himself to the control structures of structured programming, and refrains from any others, he will find no need for a flowchart. This may be a little hard to live with from the viewpoint of the older programmers. The colleges and technical schools used to teach that a flowchart had to be drawn first before code could be put down. However, a simpler type of documentation results when you write software using structured programming and pseudo-English such as:

```
open a file
read a record
while (the record is not the end) do
  process the record
  if (the record is from a female) then
    denote female record
  else
    denote male record
  endif
  output processed information
  read a record
enddo
close the file
end of program
```

A flowchart of the above process is shown in figure 2. The "while-do-enddo" process is very easily defined. In a "while-do" construct you test the condition before entering the loop. If the condition is true, you do the body of the condition and come back for another test of the condition. However, if the condition is false, then the program goes to the next line following the while-do construct. Likewise, the "if-then-else-endif" is easily defined. If the test of the condition is true, the then clause is executed. The else clause of the "if-then-else-endif" construct is executed when the results of the condition are false.

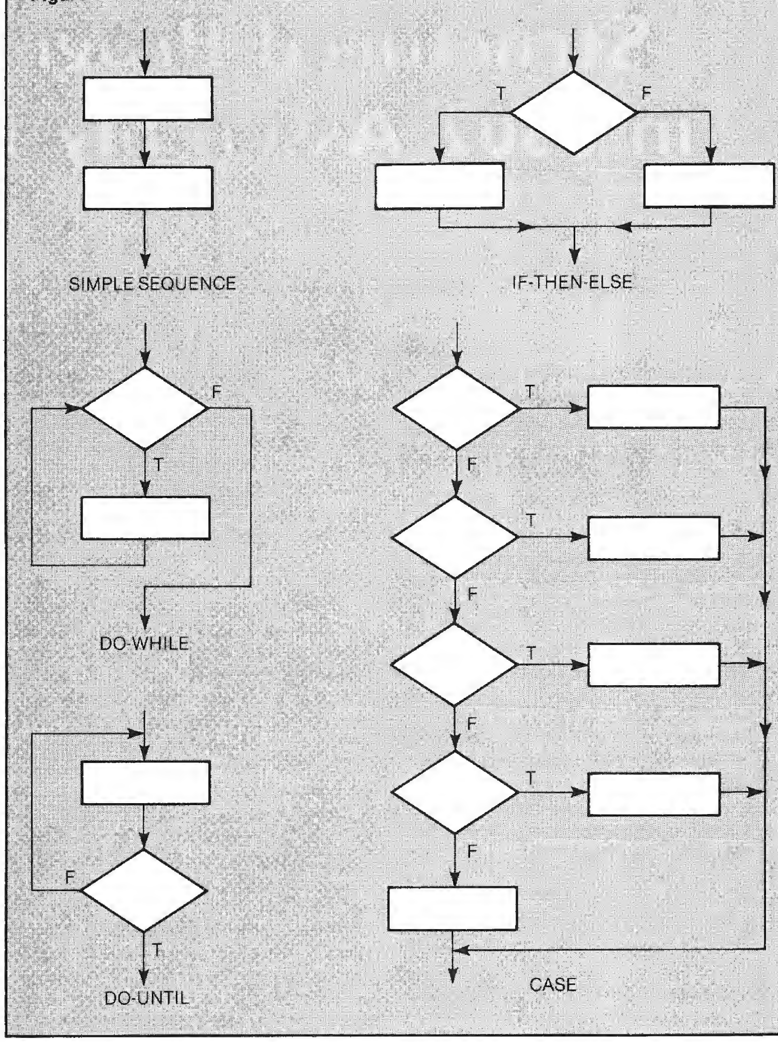
Pseudo-English is a hybrid language that uses the vocabulary of one language, English, and the overall syntax of another, structured programming. Each step of a process is described in English at whatever level of detail is appropriate at the particular level of design. This type of documentation turns out to be easier to update than a flowchart could ever be. Each pseudo-English line could represent many lines of actual programming code. This introduces the concept of leveling in the documentation. As an example, the line reading "output processed information" may represent many hundreds

of lines of pseudo code at the next level down. If I were to code this program in BASIC using the allowable control constructs, it would look like this:

```
1000 REM ** open a file **
1010 REM ** read a record **
1020 IF NOT(designation-for-end?)
     THEN 1130
1030 REM ** process the record **
1040 IF NOT(female-record?)
     THEN 1070
1050 REM ** denote female record **
1060 GOTO 1090
1070 REM cont.
1080 REM ** denote male record **
1090 REM cont.
1100 REM ** output processed infor-
     mation **
1110 REM ** read a record **
1120 GOTO 1020
1130 REM cont.
1140 REM ** close the file **
1150 END
```

The advantages of programming in this manner cannot be overstated. In BASIC the use of REM statements with ** will designate modules that have not yet been coded. When you begin writing the code that corresponds to the module, you simply remove the ** from the REM statement and insert the code. If your module is a subroutine, you remove the ** and then insert a GOSUB. You may object to the frequent use of REM as a dummy statement (such as the continue in FORTRAN). However, the use of dummy statements allows you to insert code at will into the control constructs if you have a reasonably intelligent line renumberer. BASIC control constructs corresponding to the structured programming constructs in figure 1 are shown in figure 3.

Figure 1



Now that we have a handle on what can be done in BASIC programming, how do we apply the same constructs to 6502 assembly-language programming?

What is the Problem in Assembly Language?

One problem in using decision points in 6502 assembly language is how to define the branches. A slightly more annoying problem is the 128-byte limit on the branch. We will assume that the flag registers will be set before the decision point is reached. Therefore, we can set up a number of constructs corresponding to the legal comparisons of the BASIC language. The table in figure 4 shows the flag results from a comparison between the A register and a memory location referred to by the CMP instruction. Thus the pseudo-English (with some 6502 assembly language) for three of the allowed constructs are:

(1) IF-THEN-ELSE-ENDIF

```
        setup for condition
        branch on condition to LBLZ
        JMP LBL1
LBLZ NOP
        do true part
        JMP LBL2
LBL1 NOP
        do false part
LBL2 NOP
```

(2) WHILE-DO-ENDDO

```
LBL1 NOP
        setup for condition
        branch on condition to LBLZ
        JMP LBL2
LBLZ NOP
        do body portion
        JMP LBL1
LBL2 NOP
```

(3) REPEAT-UNTIL-ENDO

```
LBL1 NOP
        do body portion
        setup for condition
        branch on condition to LBLZ
        JMP LBL1
LBLZ NOP
```

Note that in each case we have allowed for constructs that exceed 128 bytes. To illustrate the use of these constructs, suppose I had the following pseudo-English statement:

IF a = b THEN increment z ELSE decrement z ENDIF

This statement could be rendered, following our convention, in assembly language as:

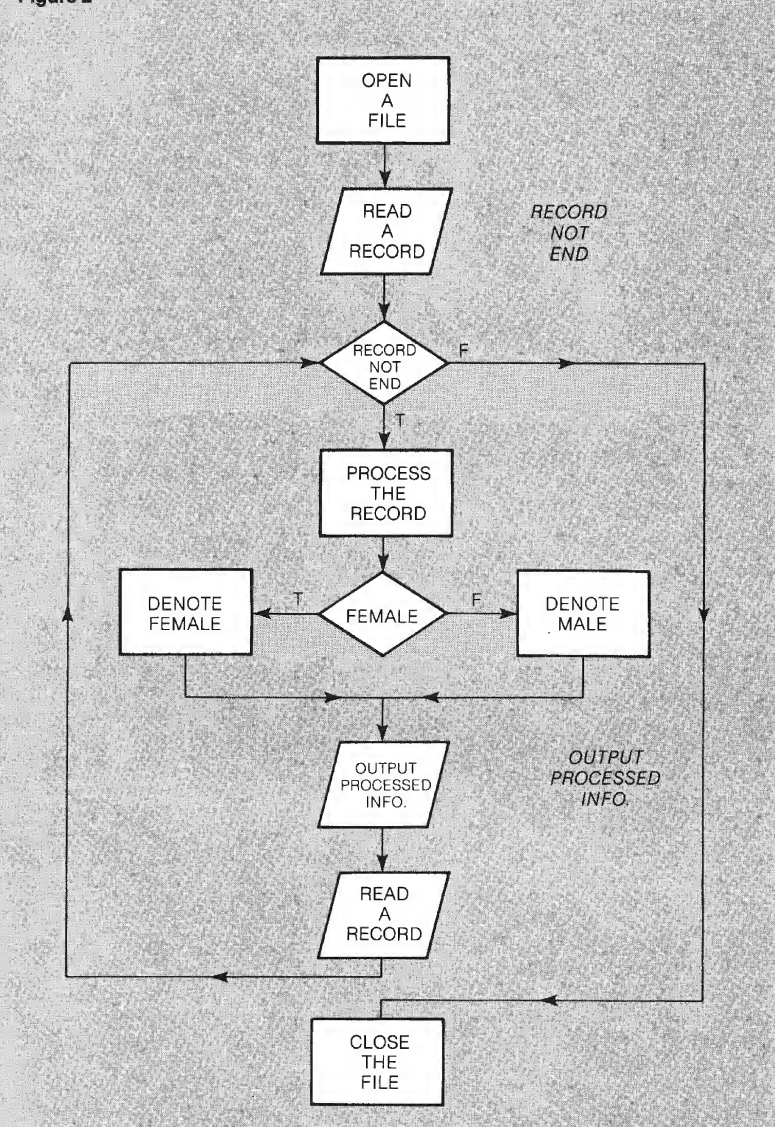
```
      LDA A
      CMP B
      BEQ LBLZ
      JMP LBL1
LBLZ  NOP
      INC Z
      JMP LBL2
LBL1  NOP
      DEC Z
LBL2  NOP
```

In each of the allowed constructs the branching is done on the inverse of the condition tested for. If we set up the conditions properly and allow for greater than 128-byte branches the conditional tests are:

(1) if a<b then part-a else part-b endif

```
      LDA A
      CMP B
      BCC LBLZ
      JMP LBL1
LBLZ  NOP
      do part-a
      JMP LBL2
LBL1  NOP
      do part-b
LBL2  NOP
```

Figure 2



(2) if a < = b then part-a else part-b endif

```
      LDA A
      CMP B
      BEQ LBLZ
      BCC LBLZ
      JMP LBL1
LBLZ  NOP
      do part-a
      JMP LBL2
LBL1  NOP
      do part-b
LBL2  NOP
```

(3) if a< >b then part-a else part-b endif

```
      LDA A
      CMP B
      BNE LBLZ
      JMP LBL1
LBLZ  NOP
      do part-a
      JMP LBL2
LBL1  NOP
      do part-b
LBL2  NOP
```

(4) if a = b then part-a else part-b endif

```
      LDA A
      CMP B
      BEQ LBLZ
      JMP LBL1
LBLZ  NOP
      do part-a
      JMP LBL2
LBL1  NOP
      do part-b
LBL2  NOP
```

(5) if a>b then part-a else part-b endif

```
      LDA A
      CMP B
      BEQ LBLX
      BCS LBLZ
LBLX  JMP LBL1
LBLZ  NOP
      do part-a
      JMP LBL2
LBL1  NOP
      do part-b
LBL2  NOP
```

(6) if a> =b then part-a else part-b endif

```
      LDA A
      CMP B
      BCS LBLZ
      JMP LBL1
LBLZ  NOP
      do part-a
      JMP LBL2
LBL1  NOP
      do part-b
LBL2  NOP
```

(7) while a<b do part-a enddo

```
LBL1 NOP
     LDA A
     CMP B
     BCC LBLZ
     JMP LBL2
LBLZ NOP
     do part-a
     JMP LBL1
LBL2 NOP
```

(8) while a<=b do part-a enddo

```
LBL1 NOP
     LDA A
     CMP B
     BEQ LBLZ
     BCC LBLZ
     JMP LBL2
LBLZ NOP
     do part-a
     JMP LBL1
LBL2 NOP
```

(9) while a<>b do part-a enddo

```
LBL1 NOP
     LDA A
     CMP B
     BNE LBLZ
     JMP LBL2
LBLZ NOP
     do part-a
     JMP LBL1
LBL2 NOP
```

(10) while a=b do part-a enddo

```
LBL1 NOP
     LDA A
     CMP B
     BEQ LBLZ
     JMP LBL2
LBLZ NOP
     do part-a
     JMP LBL1
LBL2 NOP
```

(11) while a>b do part-a enddo

```
LBL1 NOP
     LDA A
     CMP B
     BEQ LBLX
     BCS LBLZ
LBLX JMP LBL2
LBLZ NOP
     do part-a
     JMP LBL1
LBL2 NOP
```

(12) while a>=b do part-a enddo

```
LBL1 NOP
     LDA A
     CMP B
     BCS LBLZ
     JMP LBL2
LBLZ NOP
     do part-a
     JMP LBL1
LBL2 NOP
```

(13) do part-a until a<b enddo

```
LBL1 NOP
     do part-a
     LDA A
     CMP B
     BCC LBLZ
     JMP LBL1
LBLZ NOP
```

(14) do part-a until a<=b enddo

```
LBL1 NOP
     do part-a
     LDA A
     CMP B
     BEQ LBLZ
     BCC LBLZ
     JMP LBL1
LBLZ NOP
```

(15) do part-a until a<>b enddo

```
LBL1 NOP
     do part-a
     LDA A
     CMP B
     BNE LBLZ
     JMP LBL1
LBLZ NOP
```

(16) do part-a until a=b enddo

```
LBL1 NOP
     do part-a
     LDA A
     CMP B
     BEQ LBLZ
     JMP LBL1
LBLZ NOP
```

(17) do part-a until a>b enddo

```
LBL1 NOP
     do part-a
     LDA A
     CMP B
     BEQ LBLX
     BCS LBLZ
LBLX JMP LBL1
LBLZ NOP
```

(18) do part-a until a>=b enddo

```
LBL1 NOP
     do part-a
     LDA A
     CMP B
     BCS LBLZ
     JMP LBL1
LBLZ NOP
```

Let's use an example to see how these constructs work. Suppose that we need a routine to input and assemble characters to a buffer. We have a character-by-character input routine known as 'get'. Our rule is that we will fill the buffer up with each character we encounter until the first carriage return ($0D). The routine which inserts into the buffer is called 'put'. If along the way we encounter an escape character ($1B), then we will enter an escape routine called 'escp' instead of putting to the buffer. The pseudo-English version is as follows:

```
get a character
WHILE (character is not CR) DO
  IF (character is ESC) THEN
    do escape sequence
  ELSE
    add character to buffer
  ENDIF
  get a character
ENDDO
return
```

The assembly-language routine corresponding to this pseudo-English version is as follows:

```
     JSR GET          get a character
LB1  NOP                     while...
     CMP #$0D
     BNE LBZ
     JMP LB2
LBZ  NOP                         ...DO
     CMP #$1B                     IF...
     BEQ LBLZ
     JMP LBL1
LBLZ NOP                       ...THEN
     JSR ESCP
     JMP LBL2
LBL1 NOP                       ELSE...
     JSR PUT
LBL2 NOP                         ENDIF
     JSR GET           get a character
     JMP LB1
LB2  NOP                         ENDDO
     RTS                        return
```

In Conclusion

I have shown that both 6502 assembly language and BASIC can use structured programming constructs. I have also shown that by designing the program with pseudo-English statements, the structured programming constructs of necessity stand out. I have shown that structured programming allows you to modify a program with little or no change to the logic. This method allows for simplicity of maintenance and thus reduces the cost factor of the maintenance portion of the program's life cycle.

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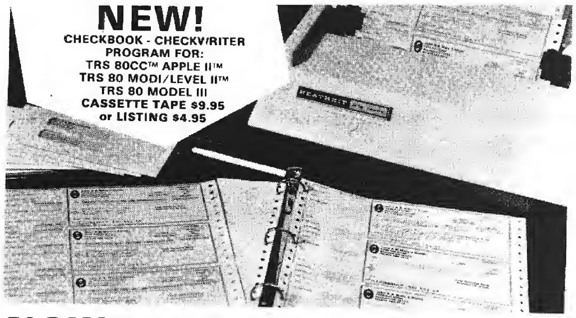

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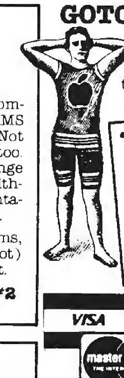

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Pattern-Matching with the 6502 on the Apple

by Charles F. Taylor, Jr.

Pattern-matching algorithms attempt to find one or more occurrences of a given character string in a specified range of memory. This article presents elementary and advanced algorithms.

Pattern Matching
Developed on an Apple II Plus, but no Apple-specific features used. Should be usable on other 6502-based microcomputers.

In this article I discuss both elementary and advanced pattern-matching algorithms and present relocatable implementations of each in 6502 assembly language. Although these programs were developed using an Apple II Plus, no Apple-specific features were used; the resulting programs should therefore be usable on the AIM, SYM, KIM, or other 6502-based microcomputer.

You may often associate pattern matching with applications such as text editing. I was motivated to pursue the topic for quite a different reason: I wanted to find and modify the jump table used for processing commands in an assembler. As I am often at least as interested in methodology as in results, I did some research on the subject and would like to share my findings.

In pattern matching we are concerned with two strings, the pattern and the target. Each string consists of a sequence of bytes. Each byte will be assumed to be devoid of any meaning other than its numerical value (0-255 decimal); for the purposes of this discussion, however, the bytes in each string will be referred to as characters and will be represented as letters in the figures.

Elementary Pattern Matching

It is easy to tell whether a pattern occurs at a particular starting position in the target string. The first character of the pattern is lined up with that starting position in the string, and corresponding characters are compared until a mismatch is found, or until the last character of the pattern has been matched. The elementary pattern-matching algorithm thus begins by aligning the pattern with the first character of the target. If a match occurs, fine. If not, the pattern is aligned with the second character of the target, and so on. The algorithm is given in a form of structured pseudo-code in figure 1, and illustrated by example in table 1. In table 1 the * indicates the pattern character at which the first mismatch occurred in each step.

Implementation on the 6502 of the algorithm of figure 1 presented several problems. Comparison of successive characters is easy, provided that the length of the pattern is restricted to 255 characters so that the Y register can be used for post-indexed addressing. This is certainly a reasonable restriction. Determining when the target string is exhausted would also be easy if the target string were restricted to 255 characters, but this was rejected as an unreasonable restriction. Such a restriction might be reasonable for a line editor with length limited to 255 characters, but it is not sufficiently general for our purposes here.

It therefore appeared as if a 16-bit comparison would be necessary each time through the main loop to determine whether or not the target string has been exhausted. This would obviously be a slow procedure with an 8-bit microprocessor. Consequently, I decided to post a sentinel or End-Of-String (EOS) character at the end of the target string so that the end of the target can be detected more easily. This requires that the target string reside in RAM as opposed to ROM, but this restriction was deemed acceptable as a design trade-off. As long as a sentinel was being used for the target string, I decided to use one for the pattern string as well. Characters displaced by the sentinels are saved on the stack and replaced upon completion of the search.

If both the target and pattern were restricted as ASCII characters, selection of character for use as a sentinel would be easy: simply use $FF, or some other unused code. Allowing each character in the pattern and target strings to take on any value from $00 to $FF makes the problem more difficult.

For a pattern restricted in length to 255 characters, there must be at least one character (two-digit hexadecimal number) which does not occur in the pattern. The problem is to find it. A solution is to start with $FF as a candidate sentinel and to compare it with each character in the pattern; if a match is found, the candidate is decremented and the process repeated until a suitable sentinel is found. Typically the process takes only one or two passes.

For the target string, there is no guarantee that a sentinel exists that does not also occur somewhere in the target (because the target may consist of more than 255 characters). The solution is to use whatever sentinel is selected for the pattern. Whenever the sentinel character is found in the target string, perform a 16-bit comparison to determine whether the target string is exhausted. This procedure takes more code, but it will be relatively fast because only rarely will the sentinel occur in the target (except in bizarre cases).

The elementary pattern-matching program is shown in listing 1. To use the program the starting address of the pattern must be placed in locations

Figure 1: **Elementary Pattern-Matching Algorithm**

```
BEGIN
BEGTAR := 0;
J := 0;
WHILE BEGTAR(=N-M DO
        WHILE TARGET(BEGTAR+J)=PATTERN(J) DO
                J := J + 1;
                IF J(=M THEN GOTO PATTERN.FOUND
        ENDWHILE;
        BEGTAR := BEGTAR + 1;
        J := 0
ENDWHILE;
PATTERN.NOT.FOUND:  RETURN 0;
PATTERN.FOUND:  RETURN BEGTAR;
END.
```

Table 1: **Example of Elementary Pattern-Matching Alorithm**

```
PATTERN: a  b  a  a  b  c

         0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16

TARGET:  a  a  b  b  a  a  b  a  a  b  a  a  b  c  a  b  c

Step: 1  a  b* a  a  b  c
      2     a  b  a* a  b  c
      3        a* b  a  a  b  c
      4           a* b  a  a  b  c
      5              a  b* a  a  b  c
      6                 a  b  a  a  b  c*
      7                    a* b  a  a  b  c
      8                       a  b* a  a  b  c
      9                          a  b  a  a  b  c
```

* First character of PATTERN at which mismatch occurs

Comparisons:

Step	TARGET	PATTERN	Match?
1	0	0	yes
	1	1	no
2	1	0	yes
	2	1	yes
	3	2	no
3	2	0	no
4	3	0	no
5	4	0	yes
	5	1	no
6	5	0	yes
	6	1	yes
	7	2	yes
	8	3	yes
	9	4	yes
	10	5	no
7	6	0	no
8	7	0	yes
	8	1	no
9	8	0	yes
	9	1	yes
	10	2	yes
	11	3	yes
	12	4	yes
	13	5	yes

Total Comparisons: 24

Figure 2: **Knuth-Morris-Pratt Algorithm**

```
BEGIN
Compute the NEXT table;
BEGTAR := 0;
J := 0;
WHILE BEGTAR(=N-M DO
        WHILE TARGET(BEGTAR+J)=PATTERN(J) DO
                J := J + 1;
                IF J)=M THEN GOTO PATTERN.FOUND
        ENDWHILE;
        IF NEXT(J)=-1 THEN
                BEGTAR := BEGTAR + J;
                J := 0
        ELSE
                BEGTAR := BEGTAR + (J - NEXT(J));
                J := NEXT(J)
        ENDIF
ENDWHILE;
PATTERN.NOT.FOUND:  RETURN 0;
PATTERN.FOUND:  RETURN BEGTAR;
END.
```

Table 2: **Example of Advanced Pattern-Matching Algorithm**

```
PATTERN: a  b  a  a  b  c

         0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16

TARGET:  a  a  b  b  a  a  b  a  a  b  a  a  b  c  a  b  c

Step: 1  a  b* a  a  b  c
      2     a  b  a* a  b  c
      3              a  b* a  a  b  c
      4                 a  b  a  a  b  c*
      5                          a  b  a  a  b  c
```

Comparisons:

Step	TARGET	PATTERN	Match?
1	0	0	yes
	1	1	no
2	1	0	yes
	2	1	yes
	3	2	no
3	4	0	yes
	5	1	no
4	5	0	yes
	6	1	yes
	7	2	yes
	8	3	yes
	9	4	yes
	10	5	no
5	10	2	yes
	11	3	yes
	12	4	yes
	13	5	yes

Total Comparisons: 17

$02-$03, the starting address of the target in $04-$05, the ending address of the target in $06-$07 (all with low-order byte first), and the pattern length in $08. The main entry point is at the beginning of the program ($6000). The result, returned in $00-$01, will be the location where the pattern was found in the target, or 0000 if the pattern was not found. A secondary entry point is provided at $6020. This may be used to continue the search for subsequent occurrences of the pattern.

Analysis of the Elementary Algorithm

The elementary pattern-matching algorithm described above is straightforward and relatively easy to implement. Closer examination of table 1, however, suggests that improvements can be found.

For convenience, let us refer to the target and the pattern as arrays of characters whose subscripts begin with 0. The first element of the pattern is thus PATTERN(0), etc. At the completion of step 2 of table 1, we have just compared TARGET(3), the fourth element of the target string, with PATTERN(2) and found a mismatch. The elementary algorithm would next compare TARGET(2) with PATTERN(0). Earlier in step 2, however, we established that TARGET(2) is a "b" (because it matches PATTERN(1)) and cannot possibly match PATTERN(0), which is an "a". Step 3 of the elementary algorithm is therefore unnecessary.

Step 4 of the elementary algorithm compares TARGET(3) with PATTERN(0). Step 2, however, established that TARGET(3) didn't match PATTERN(2), which is an "a", and that it therefore cannot match PATTERN(0), which is also an "a". Step 4 is therefore also unnecessary. Similar analysis will show that steps 7 and 8 are also unnecessary.

The problem with the elementary pattern-matching algorithm can be characterized by stating that it does not make full use of the information available to it at any given time. What information is available to it at a given time? Suppose that we are now about to look at TARGET(I) and PATTERN(J) and that all previous characters of the pattern matched the corresponding target characters. We thus know PATTERN(0), PATTERN(1),... PATTERN (J-1). In addition, because of the fact that they match, we also know TARGET(I−J+1), TARGET (I−J+2),.., TARGET(I−1). Since all previous (before TARGET(I−J+1)) target characters have not resulted in a successful match, it is not necessary to keep track of them. It is therefore sufficient at any given time for the algorithm to have knowledge of the current characters in the target and pattern strings and the previously examined characters of the pattern string. It should never be necessary to go backwards in the target string!

Advanced Pattern Matching

The algorithm demonstrated in table 2 corrects the deficiencies noted. It is called the Knuth-Morris-Pratt (KMP) algorithm, and was independently discovered by J. H. Morris in 1969 and by D.E. Knuth in 1970. V.R. Pratt, in collaboration with Knuth, refined the algorithm.

Recall that the elementary algorithm sometimes backs up to reconsider characters in the target that have already been considered. (For example, see step 7 of table 1.) It was Morris's objective to develop an algorithm that would eliminate the need to back up

the target string. This would allow him to consider characters of the target string one at a time as they were received from a file, thus eliminating the need to provide buffer space for the target file. (Notice that the KMP algorithm achieves this goal.) Considerations of efficiency were otherwise secondary. Pratt discovered that the running time of the KMP algorithm was proportional to M + N, where M is the pattern length and N is the target length. The running time of the elementary algorithm required 24 comparisons and the KMP algorithm 17 comparisons.

Elementary vs. Advanced Pattern Matching

The Knuth-Morris-Pratt algorithm is certainly more sophisticated than the elementary algorithm, but is it any better in practice? How each algorithm performs in a particular instance depends most importantly on the number of partial matches that will be encountered before the final match is found. The KMP algorithm is at its best, and the elementary algorithm at its worst, when such partial matches are numerous. When there are few partial matches, the sequence of comparisons generated by each algorithm is about the same. In such cases, however, the extra complexity required to implement the KMP algorithm incurs a penalty in speed.

It is my conclusion that for most microcomputer applications the elementary algorithm is preferable to the advanced algorithm. Not only is it simpler and more compact, it is often faster as well. A test was conducted to compare execution speed. A four-character pattern was imbedded near the end of a 32K target text. It took the elementary algorithm 1.6 seconds to find it; the KMP algorithm took 2.6 seconds.

The KMP algorithm is not the only advanced pattern-matching algorithm around. A new algorithm by Boyer and Moore shows promise for cases in which there are few partial matches. The algorithm is unfortunately even more complex in its implementation than the KMP algorithm, requiring not one but two precomputed tables. It thus seems likely that microcomputer users would do well to stay with the elementary algorithm.

References

1. Knuth, Donald E., Morris, James H. Jr., Pratt, Vaughn R., "Fast Pattern Matching in Strings," *SIAM Journal of Computing*, Vol.6, No.2, June 1977.
2. Boyer, R.S., and J.S. Moore, "A Fast String Searching Algorithm," *Communications of the ACM*, 20 (No.10), November 1977.

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Listing 1

```
                0010 ;ELEMENTARY PATTERN MATCHING
                0020 ;FOR THE 6502
                0030 ;
                0040 ; BY C. F. TAYLOR, JR.
                0050 ; 19 MAY 1981
                0060 ;
                0070 ;
                0080 ; PATTERN:  UP TO 255 CHARS
                0090 ;           PUT ADDR IN $02-$03 (LO-HI)
                0100 ;           PUT LENGTH OF PATTERN IN $08
                0110 ; TARGET:   ANY LENGTH (IN RAM)
                0120 ;           PUT START ADDR IN $04-$05
                0130 ;           PUT END ADDR IN $06-$07
                0140 ; RESULT:   $00-$01 WILL CONTAIN LOC
                0150 ;           WHERE PATTERN FOUND OR
                0160 ;           0000 IF PATTERN NOT FOUND
                0170 ;
                0180            .OS
                0190 ;
                0200 ; PAGE ZERO EQUATES
                0210 ;
                0220 LOC        .DE $00      ;RESULT LEFT HERE
                0230 PADDR      .DE $02      ;PTR TO 1ST BYTE OF PATTERN
                0240 TADDR      .DE $04      ;PTR TO 1ST BYTE OF TARGET
                                              STRING
                0250 TRGTEND    .DE $06      ;PTR TO LAST BYTE OF TARGET
                0260 LENGTH     .DE $08      ;LENGTH OF PATTERN
                0270 ;
                0280            .BA $09
0009-           0290 EOS        .DS 1        ;END-OF-STRING CHAR
000A-           0300 BEGTAR     .DS 2        ;POINTER TO TARGET STRING
000C-           0310 TEMP       .DS 2
                0320 ;
                0330            .BA $6000
                0340            ;
                0350            ;
                0360            ;INITIALIZE POINTER TO TARGET STRING
                0370            ;
6000- A5 04     0380 MATCH      LDA *TADDR
6002- 85 0A     0390            STA *BEGTAR
6004- A5 05     0400            LDA *TADDR+1
6006- 85 0B     0410            STA *BEGTAR+1
                0420            ;
6008- A9 FF     0430            LDA #$FF           ;EOS CHAR
600A- 85 09     0440            STA *EOS
600C- A4 08     0450 L1         LDY *LENGTH        ;BE SURE EOS CHAR
600E- 88        0460 L2         DEY                ;IS NOT IN PATTERN
600F- B1 02     0470            LDA (PADDR),Y
6011- C5 09     0480            CMP *EOS
6013- D0 05     0490            BNE L3
                0500            ;
                0510            ;EOS CHAR IN PATTERN, SO TRY ANOTHER
                0520            ;
6015- C6 09     0530            DEC *EOS
6017- 18        0540            CLC
6018- 90 F2     0550            BCC L1
                0560            ;
601A- 98        0570 L3         TYA                ;LOOP UNTIL ALL
601B- D0 F1     0580            BNE L2             ;CHARS CHECKED
601D- 18        0590            CLC
601E- 90 06     0600            BCC MATCH2
                0610            ;
                0620 CONTINUE   ;
                0630            ;ALTERNATE ENTRY
                0640            ;CONTINUE SEARCH AT BEGTAR+1
                0650            ;
6020- E6 0A     0660            INC *BEGTAR
6022- D0 02     0670            BNE MATCH2
6024- E6 0B     0680            INC *BEGTAR+1
6026- A0 01     0690 MATCH2     LDY #1
6028- B1 06     0700            LDA (TRGTEND),Y
602A- 48        0710            PHA                ;SAVE ORIG VALUE
602B- A5 09     0720            LDA *EOS           ;SENTINEL VALUE
602D- 91 06     0730            STA (TRGTEND),Y    ;SENTINEL FOR TARGET
602F- A4 08     0740            LDY *LENGTH
6031- B1 02     0750            LDA (PADDR),Y
6033- 48        0760            PHA                ;SAVE
6034- A5 09     0770            LDA *EOS
6036- 91 02     0780            STA (PADDR),Y      ;SENTINEL FOR PATTERN
                0790 ;
                0800 ;MAIN LOOP
                0810 ;          TEST FOR END OF TARGET
6038- A4 08     0820 WHIL1      LDY *LENGTH
603A- B1 0A     0830            LDA (BEGTAR),Y
```

(Continued)

Listing 1 *(Continued)*

```
603C- C5 09     0840            CMP *EOS           ;SENTINEL REACHED?
603E- D0 17     0850            BNE OK
                0860            ;
                0870            ;IF EOS FOUND IN TARGET,
                0880            ;MAKE SURE PAST TRGTEND
                0890            ;
6040- 18        0900            CLC
6041- 98        0910            TYA                ;TEMP:=BEGTAR+Y
6042- 65 0A     0920            ADC *BEGTAR
6044- 85 0C     0930            STA *TEMP
6046- A5 0B     0940            LDA *BEGTAR+1
6048- 69 00     0950            ADC #0             ;ADD IN CARRY
604A- 85 0D     0960            STA *TEMP+1
604C- 38        0970            SEC
604D- A5 06     0980            LDA *TRGTEND       ;TRGTEND-TEMP
604F- E5 0C     0990            SBC *TEMP
6051- A5 07     1000            LDA *TRGTEND+1
6053- E5 0D     1010            SBC *TEMP+1
6055- 90 23     1020            BCC ENDWH1         ;IF PAST TRGTEND
6057- A0 00     1030 OK         LDY #0             ;NOT PAST TRGTEND
6059- B1 02     1040            LDA (PADDR),Y
                1050            ;
                1060            ;CHECK FOR MATCH
                1070            ;
605B- D1 0A     1080 WHIL2      CMP (BEGTAR),Y     ;INNER LOOP
605D- D0 12     1090            BNE ENDWH2
605F- C8        1100            INY
6060- B1 02     1110            LDA (PADDR),Y
6062- C5 09     1120            CMP *EOS
6064- D0 F5     1130            BNE WHIL2
                1140            ;
                1150            ;PATTERN FOUND
                1160            ;
6066- A5 0A     1170            LDA *BEGTAR
6068- 85 00     1180            STA *LOC
606A- A5 0B     1190            LDA *BEGTAR+1
606C- 85 01     1200            STA *LOC+1
606E- 18        1210            CLC
606F- 90 0F     1220            BCC EXIT
                1230            ;
6071- E6 0A     1240 ENDWH2     INC *BEGTAR        ;ADVANCE POINTER
6073- D0 C3     1250            BNE WHIL1
6075- E6 0B     1260            INC *BEGTAR+1
6077- 18        1270            CLC
6078- 90 BE     1280            BCC WHIL1
                1290            ;
                1300 ENDWH1     ;PATTERN NOT FOUND
                1310            ;
607A- A9 00     1320            LDA #0
607C- 85 00     1330            STA *LOC
607E- 85 01     1340            STA *LOC+1
                1350            ;
6080- A4 08     1360 EXIT       LDY *LENGTH        ;REPLACE SENTINELS
6082- 68        1370            PLA
6083- 91 02     1380            STA (PADDR),Y
6085- A0 01     1390            LDY #1
6087- 68        1400            PLA
6088- 91 06     1410            STA (TRGTEND),Y
608A- 60        1420            RTS
                1430            .EN
```

Listing 2

```
                0010 ;ADVANCED PATTERN MATCHING
                0020 ;KNUTH-MORRIS-PRATT ALGORITHM
                0030 ;
                0040 ; 6502 VERSION BY C. F. TAYLOR, JR.
                0050 ; 20 MAY 1981
                0060 ;
                0070 ;
                0080 ; PATTERN:  UP TO 255 CHARS
                0090 ;           PUT ADDR IN $02-$03 (LO-HI)
                0100 ;           PUT LENGTH OF PATTERN IN $08
                0110 ; TARGET:   ANY LENGTH (IN RAM)
                0120 ;           PUT START ADDR IN $04-$05
                0130 ;           PUT END ADDR IN $06-$07
                0140 ; RESULT:   $00-$01 WILL CONTAIN LOC
                0150 ;           WHERE PATTERN FOUND OR
                0160 ;           0000 IF PATTERN NOT FOUND
                0170 ;
                0180            .OS
                0190 ;
                0200 ; PAGE ZERO EQUATES
```

(Continued)

Listing 2 *(continued)*

```
                 ;
                 LOC      .DE $00      ;RESULT LEFT HERE
                 PADDR    .DE $02      ;PTR TO 1ST BYTE OF PATTERN
                 TADDR    .DE $04      ;PTR TO 1ST BYTE OF TARGET STRING
                 TRGTEND  .DE $06      ;PTR TO LAST BYTE OF TARGET
                 LENGTH   .DE $08      ;LENGTH OF PATTERN
                 ;
                          .BA $09
0009-            EOS      .DS 1        ;END-OF-STRING CHAR
000A-            BEGTAR   .DS 2        ;POINTER TO TARGET STRING
000C-            TEMP     .DS 2
000E-            M        .DS 1        ;LENGTH-1
000F-            T        .DS 1        ;POINTER
0010-            J        .DS 1        ;POINTER
                 ;
                          .BA $6000
                          ;
6000- A6 08      SETUP    LDX *LENGTH  ;COMPUTE NEXT TABLE
6002- CA                  DEX
6003- 86 0E               STX *M       ;LENGTH-1
6005- A2 FF               LDX #$FF
6007- 86 0F               STX *T
6009- A0 00               LDY #0
600B- 84 10               STY *J
600D- 8A                  TXA
600E- 99 0B 61            STA NEXT,Y         ;NEXT(0):=-1
6011- C4 0E      WHIL3    CPY *M             ;FINISHED?
6013- B0 39               BCS ENDWHIL3       ;J<M
6015- A6 0F               LDX *T
6017- 30 12               BMI ENDWHIL4       ;T<=0
6019- A4 10      WHIL4    LDY *J
601B- B1 02               LDA (PADDR),Y      ;PATTERN(J)
601D- A4 0F               LDY *T
601F- D1 02               CMP (PADDR),Y      ;=PATTERN(T)?
6021- F0 08               BEQ ENDWHIL4
6023- BD 0B 61            LDA NEXT,X
6026- AA                  TAX
6027- 86 0F               STX *T             ;T:=NEXT(T)
6029- 10 EE               BPL WHIL4
602B- E8         ENDWHIL4 INX
602C- 86 0F               STX *T             ;T:=T+1
602E- E6 10               INC *J             ;J:=J+1
6030- A4 10               LDY *J
6032- B1 02               LDA (PADDR),Y      ;PATTERN(J)
6034- A4 0F               LDY *T
6036- D1 02               CMP (PADDR),Y      ;=PATTERN(T)?
6038- D0 0B               BNE L5
603A- B9 0B 61            LDA NEXT,Y
603D- A4 10               LDY *J
603F- 99 0B 61            STA NEXT,Y         ;NEXT(J):=NEXT(T)
6042- 18                  CLC
6043- 90 CC               BCC WHIL3
6045- A4 10      L5       LDY *J
6047- 8A                  TXA
6048- 99 0B 61            STA NEXT,Y         ;NEXT(J):=T
604B- 18                  CLC
604C- 90 C3               BCC WHIL3
                 ENDWHIL3
                          ;
                          ;INITIALIZE POINTER TO TARGET STRING
                          ;
604E- A5 04      MATCH    LDA *TADDR
6050- 85 0A               STA *BEGTAR
6052- A5 05               LDA *TADDR+1
6054- 85 0B               STA *BEGTAR+1
                          ;
6056- A9 FF               LDA #$FF           ;EOS CHAR
6058- 85 09               STA *EOS
605A- A4 08      L1       LDY *LENGTH        ;BE SURE EOS CHAR
605C- 88         L2       DEY                ;IS NOT IN PATTERN
605D- B1 02               LDA (PADDR),Y
605F- C5 09               CMP *EOS
6061- D0 05               BNE L3
                          ;
                          ;EOS CHAR IN PATTERN, SO TRY ANOTHER
                          ;
6063- C6 09               DEC *EOS
6065- 18                  CLC
6066- 90 F2               BCC L1
                          ;
6068- 98         L3       TYA                ;LOOP UNTIL ALL
6069- D0 F1               BNE L2             ;CHARS CHECKED
606B- 18                  CLC
606C- 90 06               BCC MATCH2
```

(continued)

Listing 2 *(continued)*

```
                          ;
                 CONTINUE ;
                          ;ALTERNATE ENTRY
                          ;CONTINUE SEARCH AT BEGTAR+1
                          ;
606E- E6 0A               INC *BEGTAR
6070- D0 02               BNE MATCH2
6072- E6 0B               INC *BEGTAR+1
                          ;
6074- A0 01      MATCH2   LDY #1
6076- B1 06               LDA (TRGTEND),Y
6078- 48                  PHA                ;SAVE ORIG VALUE
6079- A5 09               LDA *EOS           ;SENTINEL VALUE
607B- 91 06               STA (TRGTEND),Y    ;SENTINEL FOR TARGET
607D- A4 08               LDY *LENGTH
607F- B1 02               LDA (PADDR),Y
6081- 48                  PHA                ;SAVE
6082- A5 09               LDA *EOS
6084- 91 02               STA (PADDR),Y      ;SENTINEL FOR PATTERN
                 ;
                 ;MAIN LOOP
                 ;
6086- A0 00               LDY #0
6088- 84 10               STY *J             ;INITIALIZE POINTER
                          ;
                          ;END OF TARGET?
                          ;
608A- A4 08      WHIL1    LDY *LENGTH
608C- B1 0A               LDA (BEGTAR),Y
608E- C5 09               CMP *EOS           ;SENTINEL REACHED?
6090- D0 17               BNE OK
                          ;
                          ;IF EOS FOUND IN TARGET,
                          ;MAKE SURE PAST TRGTEND
                          ;
6092- 18                  CLC
6093- 98                  TYA                ;TEMP:=BEGTAR+Y
6094- 65 0A               ADC *BEGTAR
6096- 85 0C               STA *TEMP
6098- A5 0B               LDA *BEGTAR+1
609A- 69 00               ADC #0             ;ADD IN CARRY
609C- 85 0D               STA *TEMP+1
609E- 38                  SEC
609F- A5 06               LDA *TRGTEND       ;TRGTEND-TEMP
60A1- E5 0C               SBC *TEMP
60A3- A5 07               LDA *TRGTEND+1
60A5- E5 0D               SBC *TEMP+1
60A7- 90 51               BCC ENDWH1         ;IF PAST TRGTEND
60A9- A4 10      OK       LDY *J             ;NOT PAST TRGTEND
60AB- B1 02               LDA (PADDR),Y
                          ;
                          ;CHECK FOR MATCH
                          ;
60AD- D1 0A      WHIL2    CMP (BEGTAR),Y     ;INNER LOOP
60AF- D0 12               BNE ENDWH2
60B1- C8                  INY
60B2- B1 02               LDA (PADDR),Y
60B4- C5 09               CMP *EOS
60B6- D0 F5               BNE WHIL2
                          ;
                          ;PATTERN FOUND
                          ;
60B8- A5 0A               LDA *BEGTAR
60BA- 85 00               STA *LOC
60BC- A5 0B               LDA *BEGTAR+1
60BE- 85 01               STA *LOC+1
60C0- 18                  CLC
60C1- 90 3D               BCC EXIT
                          ;
                 ENDWH2   ;COMPUTE WHICH PATTERN CHAR TO EXAMINE NEXT
                          ;
60C3- B9 0B 61            LDA NEXT,Y
60C6- C9 FF               CMP #$FF           ;SPECIAL CASE
60C8- F0 18               BEQ L6
60CA- 98                  TYA                ;BEGTAR:=
60CB- 38                  SEC                ;BEGTAR+(Y-NEXT(Y))
60CC- F9 0B 61            SBC NEXT,Y
60CF- 18                  CLC
60D0- 65 0A               ADC *BEGTAR
60D2- 85 0A               STA *BEGTAR
60D4- A5 0B               LDA *BEGTAR+1
60D6- 69 00               ADC #0
60D8- 85 0B               STA *BEGTAR+1
60DA- B9 0B 61            LDA NEXT,Y
```

(continued)

Listing 2 *(continued)*

```
60DD- 85 10          STA *J
60DF- 18             CLC
60E0- 90 A6          BCC WHIL1
60E2- C8      L6     INY               ;GET NEW TARGET CHAR
60E3- 98             TYA               ;BEGTAR:=
60E4- 18             CLC               ;BEGTAR+Y
60E5- 65 0A          ADC *BEGTAR
60E7- 85 0A          STA *BEGTAR
60E9- A5 0B          LDA *BEGTAR+1
60EB- 69 00          ADC #0
60ED- 85 0B          STA *BEGTAR+1
60EF- A0 00          LDY #0
60F1- 84 10          STY *J
60F3- F0 95          BEQ WHIL1         ;ALWAYS TAKEN
60F5- E6 0B          INC *BEGTAR+1
60F7- 18             CLC
60F8- 90 90          BCC WHIL1
                     ;
              ENDWH1 ;PATTERN NOT FOUND
                     ;
60FA- A9 00          LDA #0
60FC- 85 00          STA *LOC
60FE- 85 01          STA *LOC+1
                     ;
6100- A4 08   EXIT   LDY *LENGTH       ;REPLACE SENTINELS
6102- 68             PLA
6103- 91 02          STA (PADDR),Y
6105- A0 01          LDY #1
6107- 68             PLA
6108- 91 06          STA (TRGTEND),Y
610A- 60             RTS
610B-         NEXT   .DS 256           ;ROOM FOR TABLE
                     .EN
```

Figure 3: **Construction of NEXT Table**

```
BEGIN
T := -1;
J := 0;
NEXT(0) := -1;
WHILE J<M DO
        WHILE T>0 AND PATTERN(J)<>PATTERN(T) DO
                T := NEXT(T)
        ENDWHILE;
        T := T + 1;
        J := J + 1;
        IF PATTERN(J)=PATTERN(T) THEN
                NEXT(J) := NEXT(T)
        ELSE
                NEXT(J) := T
        ENDIF
ENDWHILE;
END.
```

MICRO™

Random Number Generator in Machine Language for the Apple

by Arthur Matheny

This simple subroutine can easily be implemented in a machine-language program whenever random numbers are needed. Two examples are provided.

Random Number Generator requires:
Apple II or Apple II Plus

A random-number generator is needed in many applications — games, simulations, Monte Carlo methods, etc. The BASIC interpreter in my Apple II has a pseudo-random-number generator built in, but what about machine-language programs? I need to find the random-number routine in the BASIC ROM, but my manual does not tell me where it is located!

I decided to make a trip to the library, where I found several shelves of books about random numbers. I selected one: *The Generation of Random Variates*, written by T.G. Newman and P.L. Odell. Chapter 2 tells how to design a random-number generator, and chapter 9 tells how to test it.

The program I wrote passed all three tests that I put to it: the frequency test, the run test, and the serial test. In comparison, the random-number generator used by Apple's Integer BASIC passed the frequency test and the run test, but not the serial test. Failure to pass the serial test indicates that sequential pairs are not perfectly uncorrelated. That does not mean that the routine used by BASIC is no good; it means that mine is even better.

The execution speed can be a big factor in some applications. In the form presented here, the routine runs in 68 cycles or occasionally a few more. You can speed it up considerably by eliminating the loops and counters, thus making it into a straight-through calculation with absolute addressing.

The random number generator is given in listing 1. Before this routine is called for the first time, the main program should load seed values into memory locations $10, $11, $12, and $13. This is a pseudo-random-number generator, which means that the random sequence is predetermined by the values used to initialize these four locations.

There are two general methods to pick the seed values. At execution time you can input a number that your program uses to load the four bytes above. (The specific method that it would use to do this is not important.) If you enter the number that you executed yesterday, then you will get the results that you did yesterday. This may or may not be desirable, depending on what the program does.

The second method is to generate the seed values in some unpredictable way. For example, if you have a real-time clock, you could use its reading as a random-number seed. I do not have a real-time clock, but on the Apple, the values in memory locations $4E and $4F roll around and around whenever the computer is waiting for a keystroke from the keyboard. These make excellent seed values. All I have to do is move $4E to $10 and $12, and move $4F to $11 and $13. Whatever method

Listing 1

```
                  ;***************************
                  ;*                         *
                  ;*  6502 MACHINE LANGUAGE  *
                  ;* RANDOM NUMBER GENERATOR *
                  ;*                         *
                  ;*     BY ART MATHENY      *
                  ;*                         *
                  ;***************************
                  ;
                  ; SUBROUTINE FOR USE WITH ML PROGRAMS
                  ; USAGE: JSR $800
                  ;
                  ARRAY  EQU $10
                  ;
                  ; ARRAY IS A 4-BYTE INTEGER.
                  ; MOST SIGNIFICANT BYTE IS AT LOCATION $10.
                  ; LEAST SIGNIFICANT BYTE IS AT LOCATION $13.
                  ; LOCATIONS $10 THROUGH $13 SHOULD BE SEEDED BEFORE
                  ;     THE SUBROUTINE IS FIRST CALLED.
                  ; RESULT APPEARS IN LOCATION $10.
                  ;
0800                     ORG $800
0800 18           RND    CLC
0801 A203                LDX #3          ; NUMBER OF BYTES IN ARRAY - 1
0803 B510                LDA ARRAY,X
0805 CA                  DEX
0806 7510         LOOP1  ADC ARRAY,X
0808 9510                STA ARRAY,X
080A CA                  DEX
080B 10F9                BPL LOOP1
080D A203                LDX #3          ; ADD 1 TO ARRAY
080F F610         LOOP2  INC ARRAY,X
0811 D003                BNE RTS1
0813 CA                  DEX
0814 10F9                BPL LOOP2
0816 60           RTS1   RTS
                         END
```

you use, you only need to seed these memory locations once. When that is done, you can call the random-number generator as many times as you like.

To call the routine from a machine-language program, use JSR $800. This randomizes memory location $10. Its new value is virtually uncorrelated with its previous value. Memory location $11 is also randomized, but to a lesser degree. To call the routine from a BASIC program, use CALL 768, and then retrieve the random value by PEEK(16).

The "period" of this random-number generator is rather long. The sequence of numbers in memory location $10 will not begin to repeat itself until after 2^{32} numbers have been generated. If you expect to generate more numbers than that, change lines $801 and $80D to LDX #$4 and include memory location $14 in the initialization process.

The program in listing 2 is an example of an application of the random-number generator. It only works on an Apple II or Apple II Plus, and produces a visual effect that I call "Globular Cluster." Enter the monitor and input the program beginning at $800. To execute it, type 800G in the monitor, and use the RESET key to stop it.

I have included this program to make a point: the pattern of stars will eventually repeat, but according to a crude calculation, I estimate that this will not happen until about four years from now.

Reference

1. T.G. Newman and P.L. Odell, *The Generation of Random Variates*, Hafner Publishing Company, New York, 1971.

Art Matheny is director of computer-assisted instruction in the Biology Department at the University of South Florida. He has an MS degree in physics from Purdue University and taught physics for several years before recently turning to full-time programming. At home he has a personal computer that he uses for writing games and learning assembly language. He lives at 1405 Four Seasons Blvd., Lutz, Florida 33549.

Listing 2

```
               ;********************
               ;*                  *
               ;* GLOBULAR CLUSTER *
               ;*   FOR APPLE ][   *
               ;*                  *
               ;*  BY ART MATHENY  *
               ;*                  *
               ;********************
               ;
               ; TO EXECUTE FROM MONITOR: 800G
               ;
               QUOT   EPZ $4        ; QUOTIENT
               REM    EPZ $5        ; REMAINDER
               DVDEND EPZ $6        ; DIVIDEND
               DVSER  EPZ $7        ; DIVISOR
               SCRNX  EPZ $8        ; X-LOCATION
               KNTR   EPZ $A        ; STAR COUNTER
               DENS   EPZ $B        ; NUMBER OF STARS IN VIEW
               SPEED  EPZ $C        ; SPEED OF TRAVEL
               POINT  EPZ $D
               TUBE   EPZ $E
               RANBYT EPZ $10       ; RANDOM BYTE
               HORIZL EPZ $18       ; HORIZONTAL COORD TABLE
               HORIZH EPZ $19
               VERTL  EPZ $1A       ; VERTICAL COORD TABLE
               VERTH  EPZ $1B
               BASEL  EPZ $1C       ; DEPTH COORD TABLE
               BASEH  EPZ $1D
               TINTL  EPZ $1E       ; STAR COLOR TABLE
               TINTH  EPZ $1F
               COLOR  EPZ $30       ; COLOR FOR PLOT ROUTINE
               RNDL   EPZ $4E       ; APPLE'S RANDOM NUMBER SEED
               RNDH   EPZ $4F
               ;
               ; ROUTINES IN APPLE'S ROM
               ;
               PLOT   EQU $F800     ; LO-RES PLOT ROUTINE
               CLRSCR EQU $F832     ; CLEARS LO-RES SCREEN
               ;
               ; * * *  INITIALIZATION  * * *
               ;
0800                  ORG $800
0800 A90C             LDA #C        ; SETS NUMBER OF STARS IN VIEW
0802 850B             STA DENS
0804 A903             LDA #3        ; SETS WARP FACTOR
0806 850C             STA SPEED
0808 A90D             LDA #D
080A 850D             STA POINT
080C A9FE             LDA #FE
080E 850E             STA TUBE
0810 AD56C0           LDA $C056     ; SET LOW-RES MODE
0813 AD54C0           LDA $C054     ; DISPLAY PAGE 1
0816 AD52C0           LDA $C052     ; ALL GRAPHICS
0819 2032F8           JSR CLRSCR    ; CLEAR SCREEN
081C AD50C0           LDA $C050     ; SET GRAPHICS MODE
081F A54E             LDA RNDL      ; TRANSFER APPLE'S RANDOM SEED
0821 8510             STA $10       ; TO LOCATION $10 THRU $13
0823 8512             STA $12
0825 A54F             LDA RNDH
0827 8511             STA $11
0829 8513             STA $13
082B A90C             LDA #C        ; LOAD BASE ADDRESSES OF
                                    THE 4 TABLES
082D 8519             STA HORIZH
082F A90D             LDA #D
0831 851B             STA VERTH
0833 A90E             LDA #E
0835 851D             STA BASEH
0837 A90F             LDA #F
0839 851F             STA TINTH
083B A900             LDA #0
083D 8518             STA HORIZL
083F 851A             STA VERTL
0841 851C             STA BASEL
0843 851E             STA TINTL
0845 A40B             LDY DENS      ; CHOOSE INITIAL STAR COORDINATES
0847 20F008    NEXT   JSR NEW1
084A 88               DEY
084B D0FA             BNE NEXT
084D           ;
084D           ; * * *  MAIN LOOP  * * *
084D           ;
084D A40B      RESCAN LDY DENS
084F 840A             STY KNTR
0851 A40A      ERASE  LDY KNTR
0853 A900             LDA #0
0855 8530             STA COLOR     ; SET COLOR TO BLACK
```

(Continued)

Listing 2 *(Continued)*

```
0857 208008        JSR CALC        ; FIND OLD STAR AND ERASE IT
085A A40A          LDY KNTR        ; MOVE STAR TOWARD OBSERVER
085C B11C          LDA (BASE),Y
085E 38            SEC
085F E50C          SBC SPEED
0861 911C          STA (BASE),Y
0863 B11E          LDA (TINT),Y    ; RECALL THIS STAR'S COLOR
0865 8530          STA COLOR
0867 208008        JSR CALC        ; PLOT STAR IN ITS NEW POSITION
086A C60A          DEC KNTR        ; NEXT STAR
086C D0E3          BNE ERASE
086E F0DD          BEQ RESCAN      ; ALWAYS TAKEN
0870          ;
0870          ; * * *  CALC ROUTINE  * * *
0870          ;
0870          ; IF STAR IS ON SCREEN, PLOT IT, ELSE CREATE NEW ONE.
0870          ; ENTER WITH STAR INDEX IN Y-REG AND COLOR SET.
0870          ;
0880               ORG $880
0880 B118     CALC LDA (HORIZ),Y   ; HORIZONTAL COORDINATE
0882 20B008        JSR TAN         ; FIND HORIZONTAL SCREEN POSITION
0885 A504          LDA QUOT
0887 18            CLC
0888 6914          ADC #14         ; SHIFT ORIGIN
088A 8508          STA SCRNX
088C C928          CMP #28
088E B013          BCS EDGE        ; OFF SCREEN?
0890 B11A          LDA (VERT),Y    ; LIKEWISE FOR VERTICAL COORDINATE
0892 20B008        JSR TAN
0895 A504          LDA QUOT
0897 18            CLC
0898 6914          ADC #14
089A C928          CMP #28
089C B005          BCS EDGE
089E A408          LDY SCRNX       ; POSITION IS ON THE SCREEN
08A0 4C00F8        JMP PLOT        ; PLOT THE STAR AND RETURN
08A3 A982     EDGE LDA #82         ; OLD STAR WENT OUT OF VIEW...
08A5 911C          STA (BASE),Y    ; CREATE A NEW STAR...
08A7 4CF908        JMP NEW2        ; AND RETURN
08AA          ;
08AA          ; * * *  PROJECT 3-D POSITION ONTO 2-D SCREEN  * * *
08AA          ;
08AA          ; USES THE APPROXIMATION: X = TAN(X)
08AA          ; ACCUMULATOR = DISTANCE PERPENDICULAR TO LINE OF TRAVEL
08AA          ; (BASE),Y = DISTANCE PARALLEL TO LINE OF TRAVEL
08AA          ;
08B0               ORG $8B0
08B0 8506     TAN  STA DVDEND      ; DIVIDE PERPENDICULAR DISTANCE...
08B2 B11C          LDA (BASE),Y
08B4 8507          STA DVSER       ; BY THE PARALLEL DISTANCE
08B6 A506          LDA DVDEND      ; CHECK THE SIGN
08B8 1016          BPL DIV         ; IF +, DIVIDE AND RETURN
08BA 49FF          EOR #FF         ; TWO'S COMPLEMENT DIVIDENT
08BC 8506          STA DVDEND
08BE E606          INC DVDEND
08C0 20D008        JSR DIV         ; DIVIDE
08C3 A504          LDA QUOT        ; TWO'S COMPLEMENT QUOTIENT
08C5 49FF          EOR #FF
08C7 8504          STA QUOT
08C9 E604          INC QUOT
08CB 60            RTS
08CC          ;
08CC          ; * * *  DIVISION ROUTINE  * * *
08CC          ;
08CC          ; QUOT = 32 * DVDEND / DVSER
08CC          ; REM = REMAINDER
08CC          ;
08D0               ORG $8D0
08D0 A900     DIV  LDA #0
08D2 8504          STA QUOT
08D4 8505          STA REM
08D6 A60D          LDX POINT       ; POSITION OF DECIMAL POINT
08D8 0604     DIV1 ASL QUOT
08DA 0606          ASL DVDEND
08DC 2605          ROL REM
08DE A505          LDA REM
08E0 38            SEC
08E1 E507          SBC DVSER
08E3 9004          BCC DIV2
08E5 8505          STA REM
08E7 E604          INC QUOT
08E9 CA       DIV2 DEX
08EA D0EC          BNE DIV1
08EC 60            RTS
```

(Continued)

Listing 2 *(Continued)*

```
08ED            ;
08ED            ; * * *  RANDOMIZE  * * *
08ED            ;
08F0                   ORG $8F0
08F0 203009 NEW1       JSR RND        ; CHOOSE DISTANCE
08F3 A510              LDA RANBYT
08F5 297F              AND #7F
08F7 911C              STA (BASE),Y
08F9 203009 NEW2       JSR RND        ; CHOOSE HORIZONTAL COORDINATE
08FC A510              LDA RANBYT
08FE 250E              AND TUBE       ; AVOID COLLISIONS
0900 F0F7              BEQ NEW2
0902 9118              STA (HORIZ),Y
0904 203009 NEW3       JSR RND        ; CHOOSE VERTICAL COORDINATE
0907 A510              LDA RANBYT
0909 250E              AND TUBE       ; AVOID COLLISIONS
090B F0F7              BEQ NEW3
090D 911A              STA (VERT),Y
090F 203009 NEW4       JSR RND        ; CHOOSE COLOR
0912 A510              LDA RANBYT
0914 290F              AND #F
0916 F0F7              BEQ NEW4       ; COLOR SHOULD NOT BE BLACK
0918 8505              STA REM        ; LET UPPER NIBBLE OF COLOR-
091A 0A                ASL            ; MASK EQUAL LOWER NIBBLE
091B 0A                ASL
091C 0A                ASL
091D 0A                ASL
091E 0505              ORA REM
0920 911E              STA (TINT),Y
0922 60                RTS
0923            ;
0923            ; * * *  RANDOM NUMBER GENERATOR  * * *
0923            ;
0923            ; IDENTICAL TO LISTING 1
0923            ;
0930                   ORG $930
0930 18     RND        CLC
0931 A203              LDX #3
0933 B510              LDA $10,X
0935 CA                DEX
0936 7510   LOOP1      ADC $10,X
0938 9510              STA $10,X
093A CA                DEX
093B 10F9              BPL LOOP1
093D A203              LDX #3
093F F610   LOOP2      INC $10,X
0941 D003              BNE RTS1
0943 CA                DEX
0944 10F9              BPL LOOP2
0946 60     RTS1       RTS
                       END
```

Listing 3

```
                ;* STOCHASTIC MUSIC DEMONSTRATION *
                ;*          FOR APPLE ][          *
                ;*                                *
                ;*         BY ART MATHENY         *
                ;**********************************
                ; MERGE WITH LISTING 1
                ; TO EXECUTE FROM MONITOR: 820G
                ;
                PITCH  EPZ $5        MUSICAL PITCH
                TIME   EPZ $6        DURATION OF THE SOUND
                RANBYT EPZ $10
                RNDL   EPZ $4E
                RNDH   EPZ $4F
                RND    EQU $800
                SPKR   EQU $C030
                ;
0820                   ORG $820
0820 A54E       BEGIN  LDA RNDL        ; TRANSFER APPLE'S RANDOM SEED
0822 8510              STA $10         ; TO LOCATIONS $10 THRU $13
0824 8512              STA $12
0826 A54F              LDA RNDH
0828 8511              STA $11
082A 8513              STA $13
082C 200008     NUNOTE JSR RND         ; CHOOSE PITCH
082F A510              LDA RANBYT
0831 0980              ORA #%10000000 ; PUTS ALL NOTES IN SAME OCTAVE
0833 29F0              AND #%11110000 ; SPACES THE PITCHES WITHIN THE
0835                                  ; MUSICAL SCALE
0835 8505              STA PITCH
0837 200008            JSR RND         ; CHOOSE DURATION OF NOTE
083A A510              LDA RANBYT
083C 8506              STA TIME
083E A605       PLAY   LDX PITCH       ; X-REG TIMES THE CYCLES
0840 88         YCOUNT DEY             ; Y-REG TIMES THE PLAYING TIME
0841 D004              BNE XCOUNT
0843 C606              DEC TIME
0845 F0E5              BEQ NUNOTE
0847 CA         XCOUNT DEX
0848 D0F6              BNE YCOUNT
084A 2C30C0            BIT SPKR        ; CLICK THE APPLE SPEAKER
084D 18                CLC
084E 90EE              BCC PLAY
                       END
```

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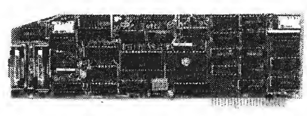

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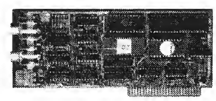

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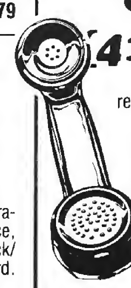

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A New Character Set for the VIC-20

by Mike Bassman

A technique to design your own VIC characters is described. This involves changing the character-ROM printer and copying character definitions into RAM from their ROM locations.

Custom Characters
requires:
VIC-20

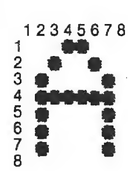
The new VIC-20 from Commodore packs a lot of wallop for $300. It includes many features that were previously found only on more expensive computers. The VIC uses a character set nearly identical to the PET's and very similar to those of Ohio Scientific, Sorcerer, and Atari computers. Special graphic characters are provided along with the regular alphanumerics. With these graphic characters, you can draw lines, build pictures, etc. The problem is that there are never enough characters available.

Although the VIC allows you to draw almost anything made of straight or curved lines, many games are more difficult to program because of the lack of tank, boat, or plane characters such as those found in OSI computers. Though the manual does not document it, it is possible to change some of the VIC's characters to those of your own choosing.

To create new characters, you must understand how the VIC stores its old ones. As with most computers, the VIC's characters are defined in an 8 by 8 dot matrix. That is, any character can be made of up to eight small dots (called pixels) across by eight down. Each pixel is represented in memory by one bit. If the bit is a 1, then the corresponding pixel will be lit when the character is displayed on the screen. An entire character consists of 64 bits, or eight bytes. The format in which the bytes are stored is as follows: the first byte represents the first row of pixels going across, the second byte is the second row, and so forth. For a more detailed example, see figure 1, where the character 'A' is shown in both pixel and binary formats.

The VIC keeps all of its characters in 4K of ROM. Since each character occupies eight bytes of memory, the ROM must contain 512 characters. At first glance, it does not seem to have that many, but this is how the 4K is used. The first 128 characters (1K) are the familiar upper case/graphics set. The next 128 are the same ones, only in reverse. This is followed by the lower/upper case set and its reverse set.

***Figure 1:* Binary Representation of Character In Memory**



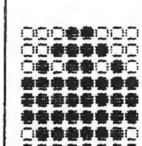
0001 1000
0010 0100
0100 0010
0111 1110
0100 0010
0100 0010
0100 0010
0000 0000

On most computers, including the PET, the character ROM is not addressed in the microprocessor's normal memory space, but is addressed so that it is only available to the CRT controller chip. In the VIC the ROM is actually addressed from $8000 to $8FFF in the 6502's address space!

Since the character information is stored in ROM, it can't be changed. However, since the pointer to the character ROM is stored in RAM, it can be changed to point anywhere else, including RAM. The pointer is at 36869, 36870. Its normal value is 240, enabling the upper case/graphic set, while a value of 242 will enable the alternate lower/upper case set. POKEing a 255 into 36869 will move the pointer from its normal 32768 address to 7168. This just happens to be right at the top of BASIC RAM, which normally runs from 4096 to 7679. By lowering the upper limit from 7679 to 7168, we have stolen 512 bytes from BASIC, or enough for 64 characters. Since it is impossible to put 4K worth of characters into 512 bytes, you have to select the 64 used most. Normally these would be the upper case letters, the numbers, and various punctuation marks, or the characters with screen codes ranging from 0 to 63. Of these, certain ones, such as the @ and the British pound sterling symbol, are seldom used, and can be replaced with your custom characters.

There are a few tricks you should know before attempting to make new characters. Most importantly, you have to reserve locations 7168 to 7679 so they are not disturbed by BASIC. There are two pointers that must be adjusted to accomplish this: the top-of-BASIC pointer (51-52), and the top-of-string storage pointer (55-56). As with every

***Figure 2:* Alien Character**



Binary	Hex	Decimal
00011000	18	24
00111100	3C	60
01011010	5A	90
11111111	FF	255
11111111	FF	255
11111111	FF	255
01111110	7E	106
01111110	7E	106

6502 pointer, the low byte is stored first, followed by the high byte. Both pointers point to 7680, and must be changed to point to 7168. Instead of recreating all of these characters, it is faster to copy them from their original ROM locations.

We are now ready to define a custom character — an alien, which you might find useful in game programs. The easiest way to go about this is to take a piece of graph paper, mark off an 8 by 8 segment, and fill in the appropriate squares. Now take each row and make a binary representation for it. Convert the binary for each row into decimal, because this information will be stored in BASIC DATA statements. Our alien is defined and digitized in figure 2.

This program will put the character shown in figure 2 over the character with screen code 0 (the '@'). Now when you hit the '@' key, you will get an alien. The alien can now be used in your own program for gaming or anything else. The unfortunate part is that all those other characters are no longer available; only the 64 you originally moved down are available. If you try to use any others, you will get whatever random gibberish happens to lie beyond 7679.

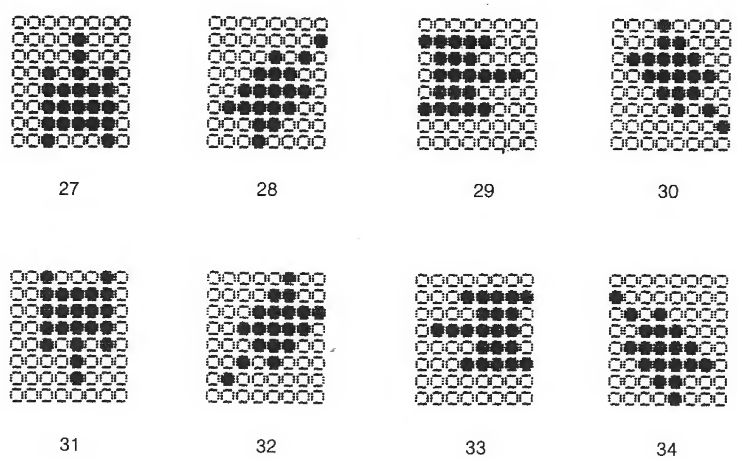
Listing 2 is a program that defines a whole series of tank characters — one for each of eight 45-degree angles. They are shown in figure 3, in their pixel formats. Below them are the screen codes they will be assuming. Now many games that were before restricted to the computers with the appropriate game characters can be programmed on the VIC.

The screen codes for the tank characters are from 27 to 34, as shown in figure 3. They are contiguous for programming ease. The tanks replace the brackets, the up and left arrows, the British pound sign, the space, the exclamation point, and the quote (in that order). If you list a program with this character set implemented, your punctuation is going to look awfully funny!

In addition to defining the tank characters, the program lets you drive the tank around the screen. The controls are 'Z' to turn left, '/' to turn right, and space to move in the direction you are pointed. To make a complete program, the lines of the program in listing 2 must be overlayed onto those of the program in listing 1.

Contact the author at 39-65 52nd St., Woodside, NY 11377.

***Figure 3:* Eight Tank Characters**



Listing 1

```
10 POKE 52,28
20 POKE 56,28
30 S=7168
40 F=32768
50 FOR K=0 TO 63*8
60 X=PEEK(F+K)
70 POKE S+K,X
80 NEXT K
90 READ X
100 IF X=-1 THEN POKE 36869,255: GOTO 1000
110 FOR K=0 TO 7
120 READ N
130 POKE S+8*K,N
140 NEXT K
150 GOTO 90
160 DATA 00,24,60,90,255,255,255,126,126
500 DATA -1
1000 PRINT "CHARACTER SET COMPLETED": END
```

Listing 2

```
5 PRINT"□": FOR K=7680 TO 8185: POKE K,35: NEXT
200 DATA 27,0,8,8,42,62,62,62,34
210 DATA 28,0,1,10,28,62,124,24,16
220 DATA 29,0,248,112,126,112,248,0,0
230 DATA 30,16,24,124,62,28,10,1,0
240 DATA 31,34,62,62,62,42,8,8,0
250 DATA 32,4,12,31,62,28,40,64,0
260 DATA 33,0,31,14,126,14,31,0,0
270 DATA 34,0,128,80,56,124,62,24,8
280 DATA 35,0,0,0,0,0,0,0,0
1000 POKE 36879,14: UL=7680: LL=22: S=35
1005 FOR K=0 TO 21: POKE UL+K,45: POKE 8164+K,45
1010 POKE UL+K*LL,45: POKE UL+K*LL+21,45: NEXT
1020 L=UL+LL*5+5:C=27:D(1)=-22:D(2)=-21:D(3)=1:D(4)=23:D(5)=22
1025 D(6)=21: D(7)=-1: D(8)=-23
1030 POKE L,C
1050 GET A$: IF A$="" THEN 1050
1060 IF A$<>"Z" THEN 1090
1070 C=C-1: IF C=26 THEN C=34
1080 GOTO 1030
1090 IF A$<>"/" THEN 1120
1100 C=C+1: IF C=35 THEN C=27
1110 GOTO 1130
1120 IF A$<>" " THEN 1050
1130 IF PEEK(L+D(C-26))<>35 THEN 1050
1140 POKE L,S: L=L+D(C-26): GOTO 1030
```

MICRO™

By Loren Wright

PET and the IEEE-488 Bus

The PET is one of the few personal computers to incorporate, as standard, support of the IEEE-488 bus. In fact, the system is built around it! Nearly all communication with peripheral devices is through the bus, and even the PET's internal devices — the screen, keyboard, and cassette interfaces — are treated as IEEE devices. Most PET owners probably know that CBM printers and disk drives are driven from the IEEE bus. However, in addition to CBM devices, the PET can also communicate with a wide variety of peripherals, produced by different manufacturers, who never even thought of connecting them to a PET. These manufacturers include Hewlett-Packard, Tektronix, Fluke, and many others; the devices include non-CBM disk drives, logic analyzers, X-Y plotters, frequency analyzers, digital voltmeters, and much more sophisticated instruments. Most other computers that can act as controllers on the bus cost much more than the PET.

A typical IEEE system includes a controller and one or more devices, which are considered listeners or talkers. Each device is assigned a number, and it will neither talk nor listen unless addressed using this number. There can be as many as 32 devices on the PET's bus, all connected at once.

The PET manipulates the devices through logical files. When a file (identified with a unique number) is OPENed, the device number is specified, as well as a secondary address, which identifies a particular function of the device. For instance, for the CBM cassette units, a secondary address of 0 allows the PET to read from the unit, a 1 to write to it, and a 2 to write, with an end-of-tape mark written when the file is CLOSEd. Once a file is open, all subsequent operations involving the specified function of the specified device need only refer to the file number.

Control of the devices is not limited to the secondary addresses. Many devices are set up to handle commands in the form of character strings. CBM disk drives are good examples of this. The secondary address 15 is the command channel, and information in the form of characters is passed in both directions on this channel. For instance, the strings "10" and "INITIALIZE0" both mean to initialize the disk in drive 0. Error and status information is sent over the channel in the other direction. For devices such as digital X-Y plotters, a character string may tell it to move the pen to 5,7 and draw a line from there to 10,12.

Programming control of IEEE devices is very easy, but physically putting together the system is even easier. Every instrument (besides the PET itself) has the same connector, and it doesn't matter which end of a cable goes where.

IEEE Tricks

When running a program that outputs data to a printer, it is often handy to be able to try it out on the screen first. You might expect to have to write your output routine first with PRINT statements, and then go back and replace them all with PRINT# statements. Here is an illustration of a technique to avoid this.

```
10 input "to printer";y$
20 if y$="y" then dv=4: goto 40
30 dv=3
40 open 1,(dv)
.
.
.
100 print#1,"first line"
110 print#1,"second line"
.
.
.
999 close 1
```

When you answer "y" to the prompt, the file will be opened with a device number of 4 and the output will go to the printer. If you answer anything else, 3 will be the assigned device number, and all output will go to the screen. If, instead of including the prompt, you had just written the 3 into the OPEN statement in line 40, then you would only have to change that one line when you finally wanted output to go to the printer. The same method could be used if you were offering the user a choice between writing data to cassette or to disk. However, the secondary addresses would have to be taken care of, too.

A question mark is always printed on a PET BASIC INPUT statement. What if you want to suppress that question mark? One way is to specify the keyboard (IEEE device 0) in an OPEN statement and use an INPUT# statement instead.

```
10 open 1,0
20 print"word: ";
30 input#1,w$
40 if w$<>"end" then 20
50 close 1
```

Notice that, unlike the INPUT command, the INPUT# command cannot include a prompt string. Notice also that hitting the return key alone doesn't phase INPUT# one bit — it must have at least one character before it is happy.

The PET's CMD command can be very handy. You have probably used it often to get BASIC listings on a printer. What it actually does is direct all output that normally goes to the screen to a logical file. After you have finished sending your listing to the printer, you may have noticed that the cursor behaves peculiarly. When you hit RETURN, it will move ahead only one space, instead of moving to the next line.

One way to restore normal keyboard operation is to type PRINT#1 (if 1 is the file number). If you aren't going to use the file again right away, it is also a good idea to close it. Remember that PRINT# can be abbreviated by typing P, followed by a shifted R. My favorite method of exiting the CMD mode is to just type some nonsense, like 'dfd.' Of course you get a syntax error, but you also exit CMD.

BASIC cannot take advantage of everything the IEEE-488 bus has to offer. With machine-language programming, it is not only possible to get the maximum in speed, but you can also do some unusual things like spooling. Wordcraft 80 and other programs allow you to send a file directly from the disk drive to the printer while you have control of the PET.

For more detailed information on the IEEE-488 bus, consult the three-part article by Gregory Yob that began with the July, 1980 issue of *BYTE* ("Get Your PET on the IEEE-488 Bus") and the book *PET and the IEEE Bus* by Eugene Fisher and C.W. Jensen, published by Osborne/McGraw-Hill (1980).

Commodore's New Machines Set Straight

With the official U.S. announcement of Commodore's newest computers at NCC in early June, it is finally clear exactly what the new models are:

Commodore-64 is a 64K color-and-sound computer designed to compete with Apple II and Atari computers. It will be available at dealers late this summer at a suggested retail of $595. It physically resembles the VIC-20, requiring a color TV or monitor and supporting all the VIC's peripherals. However, its 25 × 40 screen size, 64K of RAM, and more sophisticated graphics distinguish it. Options available include a PET emulator, IEEE-4888 cartridge, and Z-80 processor board.

The MAX machine (previously identified here and elsewhere as the Ultimax) also physically resembles the VIC-20, but it uses a flat membrane-type keyboard instead. The graphic and sound capabilities are more sophisticated. However, only 2K of RAM is included. Add-ons include a BASIC language cartridge, cassette machine, a wide variety of games, and, of course, more memory. The suggested retail will be $179.95.

The P128 is billed as the third generation in Commodore's PET line (i.e. home, educational, recreational). At a suggested retail price of $995, there is quite a bit included: 128K of RAM, expandable 256K internally and 640K externally; 25 × 40 16-color display on the user's TV or monitor; 200 × 320-pixel high-resolution graphics; built-in RS-232 and IEEE-488 interfaces; 10 programmable function keys; individual cursor movement keys; sophisticated music synthesis capability. It is also possible to add a Z-80 processor board to allow CP/M compatibility. The P128 should be available sometime in the fall.

The B128 is the new business entry in Commodore's line at a suggested retail of $1695. Internally it is very similar to the P128 described above. However, it includes an attached 80-column green phosphor screen, two 5¼" floppy disk drives, and a business keyboard. The B128 should also be available in the fall.

The BX256, very much like the B128, comes with 128K additional memory, including the 8088 processor for 16-bit capability. Suggested retail will be $2995, and it should be available in the fall.

MICRO

POWER-Aid for the PET

by F. Arthur Cochrane

This machine-language program adds commands to the BASIC programming utility POWER for the Commodore PET. The source code is in the MAE assembler format and takes advantage of conditional and interactive assembly. This allows the assembler to make decisions in its assembly and thus assemble Power-Aid to function with all three versions of POWER.

POWER-Aid
requires:

PET/CBM (all except original operating system)
POWER ROM

Editor's note: POWER was reviewed by Loren Wright in the July, 1982 "PET Vet" (MICRO 50:69).

POWER is a programmer's utility package for the PET written by Brad Templeton and sold by Professional Software, Inc. It is programmed in a 4K ROM for the $9000 socket inside the PET.

The manual, by Jim Butterfield, does an excellent job of describing POWER's commands: AUTO, DELete, DUMp, FIX, Call monitor (MLM), OFF, RENumber, SELect, TRaCe, WHY, Execute, Find, and Change. The manual also contains several appendices, including a thorough description of the memory locations used by POWER and a description of routines that can be called in POWER by the machine-language programmer. Another appendix covers adding more commands to POWER.

Three locations are used by POWER to add commands. Two of these are used for an indirect jump vector that points to the added machine code. The third location is used by POWER as a checksum for the indirect vector.

This program, Power-Aid, adds 15 more commands to POWER. Power-Aid modifies the three locations to point to itself and uses one of the POWER routines to list a BASIC line. Power-Aid can be assembled for all three POWERs by using conditional and interactive assembly available in the MAE assembler.

As presented here, Power-Aid is for

Listing 1: **POWER-Aid initialization routine demonstrates how to add commands to POWER.**

```
               ; "POWER-AID.M2A"
7900- 20 00 90 COLD       JSR POWER
7903- AD F3 7F            LDA WBEGIN        ;PROTECT EDITOR
7906- AE F4 7F            LDX WBEGIN+1      ; POINTERS
7909- 85 FB               STA *TMPO         ;SAVE TO PRINT RESTART
790B- 86 FC               STX *TMPO+1
790D- E0 80               CPX #$80          ;ABOVE RAM
790F- B0 07               BCS COLD010
7911- 85 34               STA *MEMSIZ
7913- 86 35               STX *MEMSIZ+1
7915- 20 EB 9F            JSR WRP           ;FIX POINTERS
7918- AD F5 7F COLD010    LDA WENTRY
791B- AE F6 7F            LDX WENTRY+1
791E- 8D D7 03            STA UCOMVEC       ;STORE JUMP VECTOR
7921- 8E D8 03            STX UCOMVEC+1
7924- 18                  CLC
7925- 6D F6 7F            ADC WENTRY+1
7928- 49 A5               EOR #%10100101
792A- 8D D6 03            STA UCVCHK        ;STORE CHECK BYTE
792D- A2 14               LDX #MESSGE-NGMSG
792F- 20 35 79            JSR PRTMSG
7932- 4C 1D 7E            JMP OUTDEXHEX     ;PRINT RESTART ADDRESS
               ;PRINT A MESSAGE
7935- BD 6B 7F PRTMSG     LDA NGMSG,X       ;OUTPUT MESSAGE
7938- F0 06               BEQ MSGEND
793A- 20 D2 FF            JSR PRINT
793D- E8                  INX
793E- D0 F5               BNE PRTMSG
7940- 60       MSGEND     RTS
               ; HOLD ON SPACE KEY PRESSED OR SHIFT KEY
7941- 24 98    AD70EE     BIT *SFST         ;SHIFT KEY DOWN
7943- D0 FC               BNE AD70EE        ;YES, HOLD
7945- 20 61 79            JSR AD7103
7948- D0 21               BNE AD710D
794A- 20 61 79 AD70F8     JSR AD7103
794D- F0 FB               BEQ AD70F8
794F- C9 FF               CMP #$FF
7951- F0 F7               BEQ AD70F8
7953- 48                  PHA
7954- 20 61 79 AD7100     JSR AD7103
7957- C9 FF               CMP #$FF          ;WAIT FOR KEY RELEASE
7959- D0 F9               BNE AD7100
```

(Continued)

a 32K PET, but the assembly location can easily be modified for any memory size PET. Power-Aid could also be assembled and burned into an EPROM and plugged into the $A000 socket to work with POWER. In EPROM, Power-Aid would be available with a SYS and would not have to be loaded from disk each time the PET is reset or powered up.

You might question why you should go to all the trouble of machine code. Just about all of the functions of Power-Aid could be written as instant subroutines for use by POWER. This is true, but the subroutines would be written in BASIC and would run at the speed of BASIC rather than the much faster machine code. Also, Power-Aid stores itself at the top of memory and protects itself from BASIC. If these commands were written as instant subroutines they would be overwritten on any LOAD of another BASIC program. They could be merged back in with the XEC command but their line numbers might overwrite some of the lines of the BASIC program in memory.

Listing 1 is in MAE assembly language. The object code generated with this particular assembly is for the 4040 version of POWER. Appropriate responses to the prompt will generate a version that runs on your system.

Dump the Screen to a Printer

Syntax: CRTA (, printer#)
CRTC (, printer#)

The screen is output to a printer connected to the PET. The CRTC command (to a Commodore printer) will be exactly like the screen. The CRTA command (to an ASCII printer) will be in upper case only if the PET is in graphics mode, or lower/upper case if the PET is in lower-case mode.

List a Program from the Disk

Syntax: FIL "program filename"
(, disk#)

This command will list a BASIC program on the disk directly to the screen without affecting the contents in the memory.

Convert Hex and Decimal Numbers

Syntax: HEX $hex number
HEX decimal number

The HEX command will convert hex to decimal and decimal to hex. This will be very useful in figuring

Listing 1 *(Continued)*

```
                ; ZERO CHARACTER COUNTER

795B- A9 00     ZEROCHAR   LDA #0
795D- 85 9E                STA *NDX
795F- 68                   PLA
7960- 60                   RTS


7961- AD 12 E8  AD7103     LDA $E812
7964- CD 12 E8             CMP $E812
7967- D0 F8                BNE AD7103
7969- C9 FB                CMP #$FB             ;SPACE KEY(G)/6(B)
796B- 60        AD710D     RTS

                ; POWER-AID CHECKS FOR COMMANDS

796C- A2 00     ENTRY      LDX #0
796E- 86 FE                STX *CMDLEN
7970- A1 77                LDA (TXTPTR,X)       ;CHECK FOR TOKENS
7972- 30 1C                BMI TOKEN
7974- A4 77     AD7158     LDY *TXTPTR
7976- B9 00 02  AD715A     LDA BUFOFS,Y
7979- 38                   SEC
797A- FD 9B 7F             SBC TABLE,X
797D- F0 14                BEQ AD7176
797F- C9 80                CMP #$80
7981- F0 14                BEQ AD717A
7983- E6 FE                INC *CMDLEN
7985- E8        AD7169     INX
7986- BD 9A 7F             LDA TABLE-1,X
7989- 10 FA                BPL AD7169
798B- BD 9B 7F             LDA TABLE,X
798E- D0 E4                BNE AD7158
7990- 4C FA 9F  TOKEN      JMP NORMCOM          ;NOT FOUND
7993- E8        AD7176     INX
7994- C8                   INY
7995- D0 DF                BNE AD715A
7997- 84 77     AD717A     STY *TXTPTR
7999- A5 FE                LDA *CMDLEN
799B- 0A                   ASL A
799C- AA                   TAX
799D- BD CF 7F             LDA JMPTBL,X
79A0- A8                   TAY                  ;LOW BYTE
79A1- BD D0 7F             LDA JMPTBL+1,X
79A4- AA                   TAX                  ;HIGH BYTE
79A5- 4C F7 9F             JMP ENTCMD           ;DO COMMAND
```

***Listing 2:* SPOOL command sends sequential file directly from disk to printer.**

```
                ;****
7E75- F0 31     SPOOL      BEQ UNSPOOL          ;TURN OFF PRINTER & DISK
                ;****
7E77- 20 BB 79             JSR PARCHK
7E7A- A5 D3                LDA *SA              ;SEE IF PRINTER #
7E7C- D0 02                BNE SPOOL1
7E7E- A9 04                LDA #4
7E80- 29 1F     SPOOL1     AND #%00011111
7E82- C9 04                CMP #4
7E84- 90 71                BCC SYNERR
7E86- 85 FB                STA *TMP0
7E88- A9 02                LDA #2
7E8A- 85 FD                STA *TMP2
7E8C- 20 C8 7E             JSR PARSE1
7E8F- AD 40 E8             LDA $E840            ;SET ATN
7E92- 29 FB                AND #$FB
7E94- 8D 40 E8             STA $E840
7E97- A5 FB                LDA *TMP0
7E99- 85 D4                STA *FA              ;PRINTER TO LISTEN
7E9B- 20 D5 F0             JSR LISTEN           ;LEAVE ATN HIGH
7E9E- 20 48 F1             JSR RELATNLST        ;RELEASE ATN
7EA1- A9 00                LDA #0
7EA3- 85 AF                STA *$AF             ;RESTORE INPUT TO KEYBOARD
7EA5- 85 AE                STA *OPNFILE         ;ZERO OPEN FILES
7EA7- 60                   RTS                  ;EXIT TO BASIC

7EA8- A9 02     UNSPOOL    LDA #2
7EAA- 85 AE                STA *OPNFILE         ;OPEN FILES
7EAC- A9 04                LDA #4
7EAE- 85 B0                STA *$B0             ;CMD DEVICE
7EB0- A9 08                LDA #8
7EB2- 85 AF                STA *$AF             ;INPUT DEVICE
7EB4- 20 CC FF             JSR CLRCHN           ;UNTALK & UNLISTEN
7EB7- 4C 3C 7C             JMP AD78C6           ;CLOSE FILES

7EBA- A9 00     PARSEPRG   LDA #0               ;ZERO SECONDARY FOR PRG FI
7EBC- F0 02                BEQ PAR0
7EBE- A9 02     PARSESEQ   LDA #2               ;SECOND SECONDARY FOR SEQ
7EC0- 85 FD     PAR0       STA *TMP2
```

(Continued on page 74)

POKE, PEEK, and SYS addresses. If the number input is preceded by a dollar symbol, then the number is taken as hex and the decimal value for it is printed. If a decimal number is entered then the hex value for it is returned. The range for conversion is 0 to 65535 or $0000 to $FFFF.

Put the PET into Lower Case

Syntax: LOW

This command puts the PET into lower-case mode, the same as a POKE 59468,14.

Merge a Program with One in Memory

Syntax: MRG "program filename"
(, disk#)

This command will merge a BASIC program from the disk with one in memory. The lines of the program will be merged in just as if the program were typed in from the keyboard. Therefore, lines are merged between those in memory, if necessary, and duplicate lines in memory are replaced with the merged lines. The program is listed as it is merged. This merge uses a program file, not a sequential file, which is required by POWER's XEC command.

Pack a Program

Syntax: PAC

This command will remove remarks and waste spaces in a BASIC program. Be careful not to branch in a BASIC program to deleted remarks. This command is fooled easily, so keep a copy of the original in case the packing does not function properly.

Editorial note: There may be a bug in this command, so making a backup is especially important. It works most of the time, but occasionally fails.

Read a Sequential File

Syntax: VEW "seq filename"
(, disk#)

The VEW command will read a sequential file from the disk and print it to the screen. This command can be very handy for viewing data created by programs.

Give the Size of a Program

Syntax: SIZ
SIZ "program filename"
(, disk#)

Listing 2 *(Continued)*

```
7EC2- 20 E7 FF  PARSE    JSR CLOSAL      ;CLOSE ALL FILES &  RESTOR
7EC5- 20 BB 79           JSR PARCHK      ;SET UP FILENAME
7EC8- A6 D1     PARSE1   LDX *FNLEN      ;SAVE FILENAME LENGTH
7ECA- F0 2B              BEQ SYNERR
7ECC- 86 09     PAR1     STX *TEMP
7ECE- A9 01              LDA #1          ;OPEN1,8,15
7ED0- 85 D2              STA *LF
7ED2- A9 0F              LDA #15
7ED4- 85 D3              STA *SA
7ED6- A9 00              LDA #0
7ED8- 85 D1              STA *FNLEN
7EDA- 20 63 F5           JSR OPEN
7EDD- 20 CC FF           JSR CLRCHN      ;RESET DEFAULT I/O
7EE0- A5 09              LDA *TEMP       ;RESET FILENAME LENGTH
7EE2- 85 D1              STA *FNLEN
7EE4- A9 02              LDA #2          ;OPEN2,8,2,FILENAME
7EE6- 85 D2              STA *LF
7EE8- A5 FD              LDA *TMP2
7EEA- 85 D3              STA *SA
7EEC- 20 63 F5           JSR OPEN
7EEF- 20 28 7D           JSR CHKERR      ;READ ERROR CHANNEL
7EF2- A2 02              LDX #2
7EF4- 4C C6 FF           JMP CHKIN

7EF7- A9 FF     SYNERR   LDA #$FF
7EF9- 85 37              STA *BASLIN+1
7EFB- 4C 00 BF           JMP SYNERR1
```

Listing 3: **YOU command allows loading a machine-language program at an address different from its original location.**

```
                ;**
7EFE- F0 F7     YOU      BEQ SYNERR
                ;**
7F00- 20 72 7D           JSR INPHEX      ;GET HEX ADDRESS
7F03- 20 F5 BE           JSR CHKCOM
7F06- A9 00              LDA #0
7F08- 85 9D              STA *VERCK
7F0A- A5 5F              LDA *FACC       ;LOAD ADDRESS
7F0C- A6 60              LDX *FACC+1
7F0E- 85 FC              STA *TMP0+1
7F10- 86 FB              STX *TMP0
7F12- 20 BA 7E           JSR PARSEPRG
7F15- 20 49 F4           JSR PRTSER
7F18- 20 CF FF           JSR INPUT       ;SKIP LOAD ADDRESS
7F1B- 20 CF FF           JSR INPUT
                         IFE WHICH-$4030
                         JSR LOADIT+48
                         ***
                         IFN WHICH-$4030
7F1E- 20 8C F3           JSR LOADIT+54
                         ***
7F21- 20 3C 7C           JSR AD78C6
7F24- 20 2A 7C           JSR CHKST
7F27- 4C FF B3           JMP READY
```

Listing 4: **DSK command allows change of disk drive device number.**

```
                ;**
7F2A- 20 A2 F4  DSK      JSR SCGBYT+3    ;NO COMMA CHECK
                ;**
7F2D- 20 AD 79           JSR DEVICE+3
7F30- 85 FD              STA *TMP2       ;OLD
7F32- 20 AA 79           JSR DEVICE
7F35- 85 FE              STA *TMP2+1     ;NEW
7F37- A9 00              LDA #0
7F39- 85 96              STA *ST
7F3B- A5 FD              LDA *TMP2
7F3D- 85 D4              STA *FA
7F3F- 20 D5 F0           JSR LISTEN
7F42- A9 6F              LDA #$60+15
7F44- 20 43 F1           JSR SNDSALST
7F47- A2 05              LDX #5
7F49- BD 65 7F  CHG005   LDA CHGMSG,X    ;SEND MESSAGE
7F4C- 20 9E F1           JSR BASOUT
7F4F- CA                 DEX
7F50- 10 F7              BPL CHG005
7F52- A9 20              LDA #32
7F54- 20 5F 7F           JSR CHG010
7F57- A9 40              LDA #64
7F59- 20 5F 7F           JSR CHG010
7F5C- 4C B9 F1           JMP UNLSTN

7F5F- 18        CHG010   CLC
7F60- 65 FE              ADC *TMP2+1
7F62- 4C 9E F1           JMP BASOUT
```

The SIZ command will give the size of a BASIC program in memory or any program on disk. The size of a program in memory is found by subtracting the end of the program location from the start of the program location. The size of a program on disk is found by counting the bytes in the file. The size is given in decimal and hex.

Spool a File from Disk to Printer

Syntax: SP "sequential filename"
(, disk#, printer#)
SP

This command will send a file directly from the disk to the printer. The PET can then perform other functions, such as editing a program or running a program (but with no access to the IEEE bus). The command is started with the command and a sequential file name. Power-Aid causes the PET to open the file, set the printer to listen, and then get off the IEEE bus (allowing the disk to talk directly to the printer). When the printer stops printing, enter SP with no file name to unlisten the printer, untalk the disk, and close the file.

Use the SP command to list a long program while you use the PET for something else. Create a file with

```
OPEN8,8,8,"0:TEMP,S,W":CMD8:LIST
PRINT#8:CLOSE8
```

Then spool this to the printer.

Find the Load Address

Syntax: STR "program filename"
(, disk#)

This command will give the load address of a program on the disk. The load address is found by reading the first two bytes of the file, which is the address where the program is loaded. The load address is given in decimal and hex. This command is particularly useful in determining where machine-language programs load.

Recover a Program after a NEW

Syntax: UNW

If, after a NEW command is entered, it is discovered that a program has not been saved, it can be recovered with this command.

Put the PET into Upper Case

Syntax: UP

This command puts the PET into upper-case mode, the same as a POKE 59468,12.

DOS Commands

Syntax: DC (, disk#)
DC "disk command" (, disk#)
DC "$0" (, disk#)
DL "program name" (, disk#)
EX "program name" (, disk#)

The DC command is used to read the error channel, send commands, and display the disk directory. The command alone will read the error channel and print it to the screen. The command followed by a disk command will send that command to the disk. The command followed by the dollar symbol will display the directory to the screen. The DL command will load a BASIC program from the disk. The EX command will load and run a BASIC program from the disk.

Change Disk Number

Syntax: DSK from#, to#

This command allows the disk device number to be software changed. This command performs the same function as the Change Unit Addr program on the Commodore Demo Disk.

Load at an Address You Specify

Syntax: YOU $/hex-address/,
"file name" (, disk#)

This command will force a file to load starting at the hex address you specify instead of where it would normally load.

Notes: POWER's FIX command disables Power-Aid so it must be re-enabled. The default disk number in commands is eight, and the default printer number in commands is four. The commands that print to the screen (File, Merge, View, Disk Directory) can be paused, held, or stopped. You may pause by holding the shift key down, and stop with the stop key. To hold the display, use the space bar on graphics keyboards and 6 on business keyboards. To continue the display use the ∠ key on graphics keyboards and 9 on business keyboards.

Note on Program Availability

The full listing for POWER-Aid is too long to include in MICRO. The program is available on disk from the ASM-TED Users' Group and the Toronto PET Users' Group. For 2040/4040 disk, send $10 (to cover disk, mailer, postage, and labor) and specify 'Power-Aid' disk to:

ATUG Disk Exchange
c/o Brent Anderson
200 S. Century
Rantoul, IL 61866

For 8050 disk, send $10 to:

ATUG Disk Exchange
c/o Baker Enterprises
15 Windsor Drive
Atco, NY 08004

Or send $10 for 4040 disk, $12 for 8050 disk to:

TORONTO PET Users' Group
c/o Chris Bennett
381 Laurence Avenue West
Toronto, Ontario
Canada M5M 1B9

The listings show selected portions of POWER-Aid. Listing 1 shows how new commands are added to POWER. Listings 2, 3, and 4 show the code for the added SPOOL, YOU, and DSK commands. These are assembled for the 4040 version of POWER.

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MICRO

SURCHANGE for OSI

by Kerry Lourash

This machine-language, search-and-change utility for OSI BASIC-in-ROM computers allows substitution of change strings longer than the original, and permits wild card characters in both search and change strings.

SURCHANGE
requires:
OSI machines
with BASIC-in-ROM

SURCHANGE searches for, displays, and changes code in BASIC programs. As many as seventy-one characters may be searched for and changed. Don't care characters are allowed in both search and change strings. The user may specify change strings shorter, equal to, or longer than the search string.

To avoid confusion, here are the definitions of some terms used in this article: *search string* refers to the characters SURCHANGE is told to look for. *Workspace string* is a set of characters in the BASIC program that match the search string. The *change string* is the set of characters that SURCHANGE POKEs into the BASIC program when it finds a match to the search string.

There are eight options, used singly or in pairs:

Default	Print line numbers of lines that contain workspace strings.
1. Print	Print line numbers plus workspace strings.
2. Stmt	Print line numbers plus the statements in which workspace strings are found.
3. Line	Print lines in which workspace strings are found.
4. Quote	Search only within quotes and REM statements (text).
Default	If option 4 is not chosen, search only outside of quotes and REMs (program).
5. Var	Search for occurrences of a BASIC variable (specified by the search string).
6. Change	Replace all workspace strings with the change string.

Don't care characters are allowed in both search and change strings. To il-

Listing 1

```
; SURCHANGE
;BY KERRY LOURASH
;
; ZERO PAGE
;
     BUF=$97     TEMP STORAGE FOR SEARCH CHAR.
    BUFF=$13     START OF INPUT BUFFER
   CFLAG=$98     CHANGE OPTION FLAG
  CHRCNT=$6B     # OF CHARS. IN CURRENT LINE
    CLEN=$6C     LENGTH OF CHANGE STRING
     DIF=$5D     CLEN MINUS SLEN
  ORIGIN=$9A     START OF WORKSPACE INDEX
   LFLAG=$9B     LINE OPTION FLAG
  LINCNT=$5E     # OF SCREEN LINES USED
   PFLAG=$6D     PRINT OPTION FLAG
   POINT=$6E     POINTER TO BASIC WORKSPACE
   QFLAG=$9C     QUOTE OPTION FLAG
  SCNCNT=$E      # OF CHARS SINCE LAST CR/LF
   SFLAG=$9E     STATEMENT OPTION FLAG
    SLEN=$99     LENGTH OF SEARCH STRING
    STAK=$9D     START OF SEARCH BUFFER IN STACK
   START=$79     START OF BASIC WORKSPACE
    TEXT=$60     TEXT FLAG
   VFLAG=$70     VARIABLE OPTION FLAG
  WPOINT=$AA     ADDRESS OF WORKSPACE STRING
  YINDEX=$9F     TEMP STORAGE FOR POINT INDEX
   YSAVE=$97     TEMP STORAGE FOR PRINT INDEX
;
; BROM ROUTINES
;
 DELETE=$014F    DELETE CHARS FROM PROGRAM
   BROM=$A2B4    BROM ROUTINES COPIED FROM STACK
  CHAIN=DELETE+$5A  RECHAIN BASIC LINES
 FILBUF=$A946    FILL BUFFER ROUTINE
 INCHAR=$FFEB    INPUT ONE CHAR FROM KYBD.
 LETTER=$A081    CHECK FOR LETTERS A-Z
 LIFEED=$A86C    PRINT CR/LF
 NUMBER=$00C5    CHECK FOR NUMBER 0-9
 NUMPRT=$B95E    PRINT NUMBER IN A,X
 OUTPUT=$A8E5    PRINT ONE CHARACTER
 PUSHUP=DELETE+$35  MAKE ROOM FOR LINE
 QUESTN=$A8F3    PRINT A QUESTION MARK
  RESET=$A477    RESET BASIC POINTERS
  SPACE=$A8E0    PRINT A SPACE
```

Listing 1 *(continued)*

```
                      TOGOUT=$A39D    TOGGLE VIDEO OUTPUT FLAG
                      TOKBUF=$A3A8    TOKENIZE LINE BUFFER
                      TOKIBL=$A084    START OF TOKEN TABLE
                      WARMST=$A274    ENTRY TO BASIC WARMSTART
                      ;
                      *=$7D00
                      ;
7D00 A200     OPTION LDX #0           SET PROMPT INDEX
7D02 20947F          JSR PROMPT       PRINT OPTION PROMPT
7D05 8598            STA CFLAG        ZERO FLAGS
7D07 859B            STA LFLAG
7D09 856D            STA PFLAG
7D0B 859C            STA QFLAG
7D0D 859E            STA SFLAG
7D0F 8570            STA VFLAG
7D11 855E            STA LINCNT
7D13 2046A9          JSR FILBUF       GET CHOICE OF OPTIONS
7D16 E8       OP     INX              AFTER FILBUF, X=$12
7D17 B500            LDA $0,X         EXAMINE BUFFER CONTENTS
7D19 F023            BEQ LOGIC        BRANCH IF DONE
7D1B 38              SEC              CONVERT ASCII TO NUMBER
7D1C E931            SBC #$31
7D1E A8              TAY              NUMBER TO Y REG.
7D1F D002            BNE OP1          SET CORRECT FLAG
7D21 C66D            DEC PFLAG
7D23 88       OP1    DEY
7D24 D002            BNE OP2
7D26 C69E            DEC SFLAG
7D28 88       OP2    DEY
7D29 D002            BNE OP3
7D2B C69B            DEC LFLAG
7D2D 88       OP3    DEY
7D2E D002            BNE OP4
7D30 C69C            DEC QFLAG
7D32 88       OP4    DEY
7D33 D002            BNE OP5
7D35 C670            DEC VFLAG
7D37 88       OP5    DEY
7D38 D0DC            BNE OP
7D3A C698            DEC CFLAG
7D3C D0D8            BNE OP           BRANCH ALWAYS
7D3E          ;
7D3E A698     LOGIC  LDX CFLAG        IS CHANGE FLAG SET?
7D40 F006            BEQ L1
7D42 859B            STA LFLAG        FORCE DEFAULT OPTION
7D44 856D            STA PFLAG
7D46 859E            STA SFLAG
7D48 A570     L1     LDA VFLAG        BOTH V & Q FLAGS SET?
7D4A 259C            AND QFLAG
7D4C F003            BEQ GETSUR
7D4E 20E3A8          JSR QUESTN       PRINT A QUESTION MARK
7D51          ;
7D51 A24C     GETSUR LDX #$4C
7D53 20947F          JSR PROMPT       PRINT SEARCH PROMPT
7D56 202E7F          JSR INPUT        GET SEARCH STRING
7D59 A24E     STACK  LDX #$4E         SET STACK PTR TO $014E
7D5B 9A              TXS
7D5C AA              TAX              SLEN TO X REG.
7D5D 8699            STX SLEN
7D5F E8              INX
7D60 B513     ST     LDA BUFF,X       PUSH SEARCH STRING
7D62 48              PHA              ONTO STACK
7D63 CA              DEX
7D64 10FA            BPL ST
7D66 BA              TSX              START OF SEARCH STRING
7D67 869D            STX STAK         TO STAK
7D67 869D            STX STAK         TO STAK
7D69 A2FE            LDX #$FE         RESET STACK
7D6B 9A              TXS
7D6C          ;
7D6C A598            LDA CFLAG
7D6E F029            BEQ SEARCH
7D70 A253     GETCNG LDX #$53
7D72 20947F          JSR PROMPT       PRINT CHANGE PROMPT
7D75 202E7F          JSR INPUT        PRINT & STORE CHANGE STRING
7D78 856C            STA CLEN
7D7A          ;
7D7A A296            LDX #$96         MOVE BROM ROUTINES
7D7C A089            LDY #$89         TO STACK
7D7E BDB4A2   COPY   LDA BROM,X
```

(continued)

lustrate what a don't care character is, consider the following example:

SEARCH? YXXX

I'm using "X" for the don't care symbol; in the actual program, it is CTRL-G, the ASCII BEL character. This search string finds all strings of four characters starting with a "Y". For an example of don't care characters in a change string:

CHANGE? YXXX

This change string changes only the first letter of the workspace string. The last three letters remain the same.

Using SURCHANGE

SURCHANGE can be called by POKEing its starting address into the USR vector and typing X = USR(X). To avoid typing the USR command every time, you could insert the USR command in the program you are working on as line zero. Typing RUN would then call SURCHANGE.

First, SURCHANGE prints a list of options and a prompt to select options (OPTIONS?). Options are selected by typing a combination of digits (no commas). If you make a mistake, use the usual OSI backspace (shift O). You may terminate the line and start over with a shift P, although the prompt will not be repeated. RETURN signals the end of option selection. If this procedure seems familiar, it should; you're using the Fill-the-Buffer routine of OSI BASIC.

Next, the search prompt (SEARCH?) is printed. The FTB routine is used here, too. Don't care characters are input by typing CTRL-G. If you hit RETURN without an input when typing the search or change string, SURCHANGE prints the exit prompt. If you type a "Y", SURCHANGE exits to the immediate mode. Hitting any other key causes a jump to the start of SURCHANGE.

The change prompt (CHANGE?) appears if you've chosen the change option. Only the line numbers of changes will be printed when the change option is selected. If a line is made too long (longer than 71 characters), the graphics symbol $E9 is printed after the line number.

I have attempted to provide a paged display of SURCHANGE's output. It would be nice to be able to count the number of CR/LFs generated by the video routine to determine when the screen is full. So far, I haven't figured out how to accomplish this, short of writing a separate video routine. After a certain number of lines have been printed, SURCHANGE pauses. If the space bar is hit, the display continues. Any other key causes an exit to the immediate mode without an "OK" to scroll the screen. If you use the line print option (3), you can display lines and edit them (assuming you have an editor program).

Options

Default options are automatically selected if options 1-3 or option 4 is not selected. When the change option is chosen, SURCHANGE automatically selects the default display option. If options 4 and 5 are both selected, SURCHANGE prints a question mark in front of the search prompt, since it is unlikely the user would look for a variable in the text area of a program.

The default display option displays the line numbers of lines that contain workspace strings. The numbers are displayed with a single space separating them. If a number is printed more than once, more than one workspace string is present in the line. This option allows a very dense display and calls attention to multiple occurrences of a workspace string in a line.

Option 1 displays line numbers plus the workspace string. Due to the presence of don't care characters in a search string, the workspace string may not be identical to the search string. This option is handy when don't care characters are used. Also, option one emphasizes multiple occurrences of workspace strings in a line, although its display format is not as compact as the default option's.

The statement option (2) prints the line number and the statement in which the workspace string is found (a line may contain multiple statements). Colons found at the beginning and end of the statement are also printed. The presence or absence of colons indicates the statement's position in the line:

X = 3:—statement at start of line.
:X = 3:—statement in middle of line.
:X = 3 —statement at end of line.
X = 3 —statement is the entire line.

Listing 1 *(continued)*

```
7D81 994E01            STA DELETE-1,Y
7D84 CA                DEX
7D85 E067              CPX #$67
7D87 D002              BNE CP
7D89 A25A              LDX #$5A
7D8B 88        CP      DEY
7D8C D0F0              BNE COPY
7D8E A960              LDA #$60      INSERT RTS INSTRUCTIONS
7D90 8D8001            STA DELETE+$31
7D93 8DA801            STA DELETE+$59
7D96 8DB801            STA DELETE+$69
7D99           ;
7D99 A579      SEARCH  LDA START     BASIC WORKSPACE POINTER
7D9B 856E              STA POINT     STOREDIN POINT, POINT+1
7D9D A57A              LDA START+1
7D9F 856F              STA POINT+1
7DA1 A003      NEXLIN  LDY #3        SKIP LINE POINTERS
7DA3 849A              STY ORIGIN
7DA5 A900              LDA #0        INITIALIZE TEXT FLAG
7DA7 8560              STA TEXT
7DA9 E69A      SETBUF  INC ORIGIN
7DAB A49A              LDY ORIGIN
7DAD A69D              LDX STAK      SET STACK POINTER TO
7DAF 9A                TXS           START OF SEARCH BUFFER
7DB0 68        NEXBUF  PLA           GET SEARCH CHAR.
7DB1 F04D              BEQ MATCH     FOUND A MATCH?
7DB3 C907              CMP #7        DON'T CARE CHAR?
7DB5 D002              BNE STOBUF
7DB7 B16E              LDA (POINT),Y
7DB9 8597      STOBUF  STA BUF       SAVE CHAR. IN BUF
7DBB B16E      NEXBYT  LDA (POINT),Y
7DBD AA                TAX
7DBE F01E              BEQ FIXLIN    END OF BASIC LINE?
7DC0 E08E      REM     CPX #$8E      REM TOKEN?
7DC2 F011              BEQ TOGGLE    YES, TOGGLE TEXT FLAG
7DC4 E022      QUOTE   CPX #'"
7DC6 F00D              BEQ TOGGLE
7DC8 A59C      CKTEXT  LDA QFLAG     CHECK TEXT FLAG
7DCA C560              CMP TEXT
7DCC D0DB              BNE SETBUF
7DCE E497      COMPAR  CPX BUF       DO CHARS MATCH?
7DD0 D0D7              BNE SETBUF
7DD2 C8                INY           INCREMENT WORKSPACE INDEX
7DD3 D0DB              BNE NEXBUF    BRANCH ALWAYS
7DD5 A560      TOGGLE  LDA TEXT      TOGGLE TEXT FLAG
7DD7 49FF              EOR #$FF
7DD9 8560              STA TEXT
7DDB 4CCE7D            JMP COMPAR
7DDE           ;
7DDE A8        FIXLIN  TAY           SET POINT TO NEXT LINE
7DDF B16E              LDA (POINT),Y
7DE1 AA                TAX
7DE2 C8                INY
7DE3 B16E              LDA (POINT),Y
7DE5 866E              STX POINT
7DE7 856F              STA POINT+1
7DE9 D0B6              BNE NEXLIN    END OF PROGRAM?
7DEB           ;
7DEB A25A      END     LDX #$5A
7DED 20947F            JSR PROMPT    PRINT EXIT PROMPT
7DF0 20EBFF            JSR INCHAR    GET CHAR. FROM KYBD.
7DF3 C959              CMP #'Y
7DF5 F003              BEQ DONE
7DF7 4C007D            JMP OPTION    LOOP TO START OF SURCHANGE
7DFA 4C74A2    DONE    JMP WARMST    GOTO IMMEDIATE MODE
7DFD 4C1C7F    RET     JMP RETURN
7E00           ;
7E00 88        MATCH   DEY           SAVE WORKSPACE INDEX
7E01 849F              STY YINDEX
7E03 A2FE              LDX #$FE      RESET STACK
7E05 9A                TXS
7E06           ;
7E06 A570      VARIBL  LDA VFLAG     TEST VARIABLE FOUND
7E08 F01C              BEQ LINE
7E0A A49A              LDY ORIGIN    INDEX TO START OF STRING
7E0C C004              CPY #4        FIRST CHAR. IN LINE?
7E0E F006              BEQ VO
7E10 88                DEY           GET PREVIOUS CHARACTER
7E11 B16E              LDA (POINT),Y
```

Listing 1 *(continued)*

```
7E13 20237F          JSR LEGAL     IS IT A ALPHANUMERIC CHAR?
7E16 A49F     V0     LDY YINDEX    GET CHAR. IN FRONT OF STRING
7E18 C8       V1     INY
7E19 B16E            LDA (POINT),Y
7E1B C924            CMP #'$
7E1D F0DE            BEQ RET
7E1F C928            CMP #'(
7E21 F0DA            BEQ RET
7E23 20237F          JSR LEGAL
7E26          ;
7E26 A002     LINE   LDY #2        GET 2-BYTE LINE #
7E28 B16E            LDA (POINT),Y
7E2A AA              TAX
7E2B C8              INY
7E2C B16E            LDA (POINT),Y
7E2E 205EB9          JSR NUMPRT    CONVERT TO ASCII, PRINT
7E31 E8       LIN    INX           PUT # OF DIGITS IN CHRCNT
7E32 BD0001          LDA $0100,X
7E35 D0FA            BNE LIN
7E37 866B            STX CHRCNT
7E39          ;
7E39 A56D     PCHECK LDA PFLAG
7E3B D044            BNE FINI
7E3D A59E     SCHECK LDA SFLAG
7E3F F02E            BEQ LCHECK
7E41 A49F            LDY YINDEX    FIND END OF LINE
7E43 B16E     S0     LDA (POINT),Y  OR TERMINATING COLON
7E45 F013            BEQ S2
7E47 C8              INY
7E48 C922            CMP #'"
7E4A D006            BNE S1
7E4C A560            LDA TEXT      TOGGLE TEXT FLAG
7E4E 49FF            EOR #$FF      IF QUOTE IS FOUND
7E50 8560            STA TEXT
7E52 2460     S1     BIT TEXT      LOOP IF IN TEXT
7E54 30ED            BMI S0
7E56 C93A            CMP #':
7E58 D0E9            BNE S0
7E5A 88       S2     DEY
7E5B 849F            STY YINDEX    SAVE NEW END OF STRING'
7E5D A49A            LDY ORIGIN    LOOK BACK THRU LINE
7E5F B16E     BACKWD LDA (POINT),Y
7E61 88              DEY
7E62 C93A            CMP #':
7E64 F004            BEQ BA
7E66 C003            CPY #3        AT START OF LINE?
7E68 D0F5            BNE BACKWD
7E6A C8       BA     INY
7E6B 849A            STY ORIGIN    SAVE NEW START OF LINE
7E6D D012            BNE FINI
7E6F A59B     LCHECK LDA LFLAG
7E71 F03E            BEQ CHANGE
7E73 A49F            LDY YINDEX    FIND END OF LINE
7E75 C8       LC     INY
7E76 B16E            LDA (POINT),Y
7E78 D0FB            BNE LC
7E7A 88              DEY
7E7B 849F            STY YINDEX    SAVE END OF LINE
7E7D A004            LDY #4
7E7F 849A            STY ORIGIN    START OF LINE IS ALWAYS 4
7E81 20E0A8   FINI   JSR SPACE     PRINT SPACE
7E84 204E7F          JSR PLINE     PRINT LINE
7E87          ;
7E87 E65E     COUNTR INC LINCNT    CHECK # OF CHARS. IN LINE
7E89 A56B            LDA CHRCNT    AND INCREMENT COUNT AS NEEDED
7E8B C917            CMP #$17      ** C2P: CHANGE TO #$3F **
7E8D 9008            BCC CHEC
7E8F C92F            CMP #$2F      ** C2P: CHANGE TO #$7F **
7E91 9002            BCC ADD1
7E93 E65E            INC LINCNT
7E95 E65E     ADD1   INC LINCNT
7E97 A55E     CHEC   LDA LINCNT
7E99 C90F            CMP #$F       COUNT <= 15 LINES?
7E9B 900E            BCC CONT
7E9D A900            LDA #0
7E9F 855E            STA LINCNT
7EA1 20EBFF          JSR INCHAR    GET KYBD. INPUT
7EA4 C920            CMP #$20      IS INPUT A SPACE CHAR?
7EA6 F003            BEQ CONT
```

(continued)

Option 2 allows the user to follow the use of a variable throughout a program or to examine all occurrences of any token (and its arguments) in a program. A statement is printed only once, even if it contains more than one workspace string. For example, in the statement A = A − 3 the variable A occurs twice. If "A" were the search string, the statement would only be printed once.

The line option (3) lets the user see the entire line that contains the workspace string. This option displays a maximum amount of information, but also fills the screen rapidly. Like the statement option, the line option prints a line only once, even if it contains more than one workspace string. The line option can be used as an aid to edit individual lines. With SURCHANGE, find the lines to be edited; exit the SURCHANGE program; and either use an editor to change the lines, or retype them.

The quote option (4) searches the text portion of a BASIC program. Text includes PRINT statements, INPUT prompts, string variables, string DATA elements, and REM statements. Due to the structure of SURCHANGE, the initial quotation mark of a string is not considered to be part of the text. If the quote option is not chosen, SURCHANGE searches the program area outside of quotes and REMs.

The reason for defining two areas of search is that BASIC tokenizes its keywords (USR, POKE, NULL, etc.), unless the words are in REMs or quotes. A token is a one-byte code for a keyword. BASIC saves memory space and increases execution speed because it stores and reads only one byte, instead of a whole keyword. Thus, if you're searching for "ON", SURCHANGE needs to know whether you mean the word "ON" or the one-byte token for the keyword ON.

The variable option (5) helps search for a BASIC variable. In a normal search, looking for the variable "A" might find other variables such as A$, AB, A(X), etc. When the variable option is chosen, every variable found is tested to be sure it's not a subset of another variable.

The change option (6) enables modification of a BASIC program. Change strings may be shorter, equal in length, or longer than the search string. This is a powerful option and should always be used with caution. Unless changing text, SURCHANGE will tokenize the

change string before it is inserted in the program. Therefore, the change string may look deceptively longer or shorter than the search string when it is printed on the screen. For example, "RETURN" is one byte long when tokenized, while "A=6" is three bytes long. If "A=6" is substituted for RETURN, all lines changed will be two bytes longer.

If a line is longer than 71 bytes, it can still be LISTed, SAVEd, and even RUN. When you try to LOAD a long line, however, you'll find that the line is too long to fit into the input buffer. SURCHANGE prints a graphic character $E9 after a line number when the line becomes too long. Be sure to remember which lines are too long; they are identified only when the line is being changed, not during search operations.

Finding Your Way Around

SURCHANGE takes getting used to. I suggest you type in a ten- to twenty-line program and practice finding and changing things before you do any serious work. Here are a few tricks I've used!

To delete all non-text spaces in a program, select option 6. Type a space and a don't care character for the search string. Now, type a single don't care character for the change string. This gets rid of almost all single spaces and partially erases multiple spaces. Repeat as needed to erase all spaces. This strategy may work with other items you wish to delete.

When typing in a program, use a "%" or other seldom-used character to stand in for a phrase which is inserted by SURCHANGE after the program is completed. Of course, you must be careful not to make a line too long by the insertion.

Lines of up to 255 characters can be created with the change option. They use less memory space and run faster than normal lines. The big disadvantage of long lines is that they have to be saved and loaded in a machine-language format.

Changing SURCHANGE

C2/4P owners should change the COUNTR routine as noted in the listing. They may also want to eliminate the CR/LF between the two lines of options in the option prompt. The easiest method is to substitute two spaces ($20) for the $D, $A after

Listing 1 *(continued)*

```
2820 7EA8 4C7DA2          JMP $A27D      GOTO IMM. MODE; NO OK MESS.
2830 7EAB 206CA8   CONT   JSR LIFEED     PRINT CR/LF
2840 7EAE 4C1C7F          JMP RETURN     RESUME SEARCH
2850 7EB1          ;
2860 7EB1 A598     CHANGE LDA CFLAG
2870 7EB3 F067            BEQ RETURN
2880 7EB5 18              CLC            CALCULATE ABSOLUTE ADDRESS
2890 7EB6 A59A            LDA ORIGIN     OF START OF WORKSPACE STRING
2900 7EB8 656E            ADC POINT
2910 7EBA 85AA            STA WPOINT
2920 7EBC A46F            LDY POINT+1
2930 7EBE 9001            BCC CH
2940 7EC0 C8              INY
2950 7EC1 84AB     CH     STY WPOINT+1
2960 7EC3 38              SEC
2970 7EC4 A56C            LDA CLEN       FIND CLEN MINUS SLEN
2980 7EC6 E599            SBC SLEN
2990 7EC8 F02E            BEQ CEQUAL     IF CLEN = SLEN
3000 7ECA 900C            BCC MOVDWN
3010 7ECC 855D     MOVEUP STA DIF        MAKE ROOM FOR LONGER STRING
3020 7ECE C65D            DEC DIF
3030 7ED0 208401          JSR PUSHUP
3040 7ED3 20857F          JSR REPLAC     INSERT CHANGE STRING
3050 7ED6 301A            BMI MV3
3060 7ED8 A47B     MOVDWN LDY $7B        SET UP VARIABLES FOR DELETESUB
3070 7EDA 8471            STY $71
3080 7EDC A4AB            LDY WPOINT+1
3090 7EDE 8474            STY $74
3100 7EE0 48              PHA
3110 7EE1 38              SEC
3120 7EE2 A599            LDA SLEN
3130 7EE4 E56C            SBC CLEN
3140 7EE6 18              CLC
3150 7EE7 65AA            ADC WPOINT
3160 7EE9 9001            BCC MV2
3170 7EEB C8              INY
3180 7EEC 8472     MV2    STY $72
3190 7EEE 68              PLA
3200 7EEF 204F01          JSR DELETE     ERASE XTRA CHARS. FROM PROGRAM.
3210 7EF2 2077A4   MV3    JSR RESET      RESET BASIC POINTERS
3220 7EF5 20A901          JSR CHAIN      RECHAIN LINE POINTERS
3230 7EF8 20857F   CEQUAL JSR REPLAC
3240 7EFB 209DA3   LONG   JSR TOGOUT     CHECK FOR LONG LINE
3250 7EFE A0FF            LDY #$FF
3260 7F00 849F            STY YINDEX
3270 7F02 A004            LDY #4
3280 7F04 20507F          JSR PLINE+2
3290 7F07 209DA3          JSR TOGOUT
3300 7F0A 18              CLC
3310 7F0B A56C            LDA CLEN       FIND NEW END OF STRING
3320 7F0D 659A            ADC ORIGIN
3330 7F0F 859F            STA YINDEX
3340 7F11 A56B            LDA CHRCNT     IS LINE TOO LONG?
3350 7F13 C947            CMP #$47
3360 7F15 9005            BCC RETURN
3370 7F17 A9E9     TOOLNG LDA #$E9       PRINT GRAPHIC CHAR.
3380 7F19 20E5A8          JSR OUTPUT
3390 7F1C A49F     RETURN LDY YINDEX
3400 7F1E 849A            STY ORIGIN
3410 7F20 4CA97D          JMP SETBUF     RESUME SEARCH
3420 7F23          ;
3430 7F23 20C500   LEGAL  JSR NUMBER     IS CHAR =0-9?
3440 7F26 90F4            BCC RETURN
3450 7F28 2081AD          JSR LETTER     IS CHAR =A-Z?
3460 7F2B B0EF            BCS RETURN
3470 7F2D 60              RTS
3480 7F2E          ;
3490 7F2E 850E     INPUT  STA SCNCNT     ZERO VIDEO CHAR COUNTER
3500 7F30 2046A9          JSR FILBUF     PRINT AND STORE INPUT
3510 7F33 88              DEY            Y=#$FF
3520 7F34 C8       LILOOK INY            COUNT # OF CHARS. IN INPUT
3530 7F35 B91300          LDA BUFF,Y
3540 7F38 D0FA            BNE LILOOK
3550 7F3A 88       TOKIZE DEY
3560 7F3B 1003            BPL TKO
3570 7F3D 4CEB7D          JMP END        IF NULL INPUT
3580 7F40 98       TKO    TYA            SHOULD STRING BE TOKENIZED?
```

Listing 1 *(continued)*

```
7F41 A49C            LDY QFLAG
7F43 D008            BNE RTN
7F45 E8              INX
7F46 20ABA3          JSR TOKBUF    TOKENIZE STRING
7F49 98              TYA           FIND LENGTH OF STRING
7F4A 38              SEC
7F4B E906            SBC #6
7F4D 60      RTN     RTS
7F4E         ;
7F4E A49A    PLINE   LDY ORIGIN    PRINT WORKSPACE STRING
7F50 8497    PO      STY YSAVE
7F52 B16E            LDA (POINT),Y
7F54 F0F7            BEQ RTN       END OF LINE?
7F56 101E            BPL PRINT     BRANCH IF NOT A TOKEN
7F58 38      TOKEN   SEC           FIND KEYWORD IN TABLE
7F59 E97F            SBC #$7F
7F5B AA              TAX
7F5C A0FF            LDY #$FF
7F5E CA      TO      DEX
7F5F F008            BEQ T2
7F61 C8      T1      INY           PRINT KEYWORD
7F62 B984A0          LDA TOKTBL,Y
7F65 10FA            BPL T1
7F67 30F5            BMI TO
7F69 C8      T2      INY
7F6A B984A0          LDA TOKTBL,Y
7F6D 3007            BMI PRINT     PRINT LAST CHAR. IN KYWORD
7F6F E66B            INC CHRCNT
7F71 20E5A8          JSR OUTPUT
7F74 D0F3            BNE T2
7F76 297F    PRINT   AND #$7F      ZERO HI BIT
7F78 20E5A8          JSR OUTPUT    PRINT CHARACTER
7F7B E66B            INC CHRCNT
7F7D A497            LDY YSAVE     DONE PRINTING LINE?
7F7F C49F            CPY YINDEX
7F81 C8              INY
7F82 90CC            BCC PO
7F84 60              RTS
7F85         ;
7F85 A46C    REPLAC  LDY CLEN      INSERT CHANGE STRING
7F87 B91300  REO     LDA BUFF,Y
7F8A C907            CMP #7        DON'T CARE CHAR?
7F8C F002            BEQ RE1
7F8E 91AA            STA (WPOINT),Y
7F90 88      RE1     DEY
7F91 10F4            BPL REO       BRANCH ALWAYS
7F93 60              RTS
7F94         ;
7F94 BDA07F  PROMPT  LDA TABL,X    PRINT A MESSAGE
7F97 E8              INX
7F98 C60E            DEC SCNCNT    AVOID AUTO CR/LF
7F9A 20E5A8          JSR OUTPUT    PRINT ONE CHARACTER
7F9D D0F5            BNE PROMPT    LOOP IF CHAR NOT A NULL
7F9F 60              RTS
7FA0         ;
7FA0         TABL
7FA0 0D      .BYTE $D,$A,'SEARCH '
7FA1 0A
7FA2 53
7FA3 45
7FA4 41
7FA5 52
7FA6 43
7FA7 48
7FA8 20
7FA9 4F      .BYTE 'OPTIONS:',$D,$A
7FAA 50
7FAB 54
7FAC 49
7FAD 4F
7FAE 4E
7FAF 53
7FB0 3A
7FB1 0D
7FB2 0A
7FB3 20      .BYTE ' 1-PRINT 2-STMT'
7FB4 31
7FB5 2D
7FB6 50
```

(continued)

"3-LINE" in TABL at the end of the program.

If you wish to examine the BASIC-in-ROM routines copied to the stack, or if you must move them to another location, simply change the DELETE label to the start of the new location.

SURCHANGE is relocatable from object code with the exception of references to the prompt table (TABL). All references to TABL should be adjusted to conform to its new location.

How SURCHANGE Works

SURCHANGE occupies three pages of RAM and uses part of the stack for BASIC-in-ROM routines and the search buffer. It wipes out the NMI and IRQ vectors. To conserve zero page space for other accessory programs, SURCHANGE uses only zero page addresses normally used by BASIC. The change buffer is located in the line buffer ($13-5A).

To start, OPTION prints a list of options and the option prompt. The option flags are zeroed and FILBUF is called to find out what options are desired. When the options have been specified, their respective flags are set. LOGIC selects the default print option if the change flag is set, and prints a question mark in front of the search prompt if both the variable and quote flags are set.

GETSUR prints the search prompt and calls INPUT. INPUT zeros the video character counter ($E) so a full 71-character line can be typed without a premature CR/LF. FILBUF is called again to store and print the search string. After the search string is typed in, the number of characters in the string is counted. If no string has been input, the routine goes to END to see if the user wishes to start over. If the search is to be conducted within quotes, the tokenize-the-buffer routine (TOKBUF) is skipped. The number of characters in the string is returned in the A register.

INPUT returns to STACK, where the stack pointer is set to $014E and the length of the search string is stored in SLEN. The search string is pushed onto the stack and the stack pointer position saved in STAK. The stack pointer is then reset to the top of the stack.

If the change option has been selected, GETCNG prints the change prompt and INPUT is called to get the

change string. When INPUT returns, the length of the change string is stored in CLEN.

COPY transfers BASIC-in-ROM routines for inserting, deleting, and rechaining BASIC lines to the stack, and inserts RTS instructions to make them subroutines.

The Search Begins

The start-of-BASIC workspace pointer is transferred to SURCHANGE's workspace pointer (POINT). NEXLIN sets the Y register to index the start of the BASIC line, and TEXT, the quote status flag, is cleared. ORIGIN is initialized to the start of the line. The stack pointer is set to the start of the search buffer. A character is pulled from the stack. Naturally, the contents of the stack are not altered by this operation, and SURCHANGE can re-examine the search buffer any number of times. If the character is a null, SURCHANGE has found a match to the search string and goes to the MATCH routine. If it is a don't care character, the next character in the BASIC workspace is stored in BUF. Later, when the workspace character is compared to BUF, the two will match. If the search character is not a null or don't care byte, it's stored in BUF.

NEXBYT tests the next character in the workspace. If the workspace character is a null, the end of the BASIC line has been reached. The routine branches to FIXLIN to reset POINT to the next line or to exit, if at the end of the program. If the workspace character is a REM token or a quotation mark, the TEXT flag is toggled. This means if TEXT is zero, it's changed to #$FF, and *vice versa*. If TEXT is not equal to the quote option flag, SURCHANGE loops back to SETBUF. Finally, at COMPAR, the search character is compared to the workspace character. If the two are identical, the next search character is pulled from the stack and the NEXBUF loop is done again. If the characters don't match, the stack pointer is reset to the start of the search buffer, the workspace counter (ORIGIN) is incremented, and SURCHANGE starts looking for a workspace string again.

FIXLIN, as mentioned before, transfers the BASIC next-line pointer to POINT. If the high byte of the pointer is zero, the end of the BASIC program has been reached. The stack pointer is set to the top of the stack, "EXIT?" is printed, and SURCHANGE waits for an input. At this point, the user can hit Y and exit to the BASIC immediate mode

Listing 1 *(continued)*

```
4170 7FB7 52
4170 7FB8 49
4170 7FB9 4E
4170 7FBA 54
4170 7FBB 20
4170 7FBC 32
4170 7FBD 2D
4170 7FBE 53
4170 7FBF 54
4170 7FC0 4D
4170 7FC1 54
4180 7FC2 20           .BYTE ' 3-LINE',$D,$A
4180 7FC3 33
4180 7FC4 2D
4180 7FC5 4C
4180 7FC6 49
4180 7FC7 4E
4180 7FC8 45
4180 7FC9 0D
4180 7FCA 0A
4190 7FCB 20           .BYTE ' 4-QUOTE 5-VAR 6-'
4190 7FCC 34
4190 7FCD 2D
4190 7FCE 51
4190 7FCF 55
4190 7FD0 4F
4190 7FD1 54
4190 7FD2 45
4190 7FD3 20
4190 7FD4 35
4190 7FD5 2D
4190 7FD6 56
4190 7FD7 41
4190 7FD8 52
4190 7FD9 20
4190 7FDA 36
4190 7FDB 2D
4200 7FDC 43           .BYTE 'CHANGE',$D,$A
4200 7FDD 48
4200 7FDE 41
4200 7FDF 4E
4200 7FE0 47
4200 7FE1 45
4200 7FE2 0D
4200 7FE3 0A
4210 7FE4 4F           .BYTE 'OPTIONS',0
4210 7FE5 50
4210 7FE6 54
4210 7FE7 49
4210 7FE8 4F
4210 7FE9 4E
4210 7FEA 53
4210 7FEB 00
4220 7FEC 53           .BYTE 'SEARCH',0
4220 7FED 45
4220 7FEE 41
4220 7FEF 52
4220 7FF0 43
4220 7FF1 48
4220 7FF2 00
4230 7FF3 43           .BYTE 'CHANGE',0
4230 7FF4 48
4230 7FF5 41
4230 7FF6 4E
4230 7FF7 47
4230 7FF8 45
4230 7FF9 00
4240 7FFA 45           .BYTE 'EXIT?',0
4240 7FFB 58
4240 7FFC 49
4240 7FFD 54
4240 7FFE 3F
4240 7FFF 00
```

or hit any other key to rerun SURCHANGE.

A Match is Found

If a match to the search string is found, the workspace index (Y) to POINT is stored in YINDEX. The stack pointer is set to the top of the stack.

If VFLAG is set, VARIBL tests the characters adjacent to the workspace string to see if the string is a subset of another variable. If the correct variable has not been found, LEGAL jumps back into the search loop.

LINE finds the current line number in the workspace and prints it. It also counts the number of digits in the line number for later use in the COUNTR or LONG routines.

PCHECK prints a space and the workspace string if the print flag is set.

SCHECK finds the terminating colon of the statement or the end of the line. BACKWD finds the start of the statement or the start of the line. I was strapped for space here; I didn't include a check in BACKWD to be sure a colon is really a statement separator and not part of a string.

LCHECK finds the start and end of the line. The start is easy; always the fourth byte from the beginning of the line. FINI prints a space to separate line number and line, and then PLINE prints all or part of the line and counts the characters in the line.

COUNTR looks at the number of characters in the line just printed and decides whether LINENT, the line counter, shall be incremented by one, two, or three. CHEC decides if enough lines have been printed. If so, it calls INCHAR, which waits for a keystroke. Any other key causes an exit to the immediate mode, without the "OK" message.

Changing Things Around

CHANGE tests CFLAG and, if it is set, subtracts the length of the search string (SLEN) from the length of the change string (CLEN). If the two are equal, CHANGE goes directly to CEQUAL, where the change string replaces the workspace string. If CLEN is longer than SLEN, MOVEUP calls PUSHUP, a routine copied from ROM. PUSHUP makes room in the BASIC workspace for the longer change string. REPLAC is called to insert the change string into the BASIC program. LONG tests the new line length to see if it's longer than 71 characters. A graphics character $E9 is printed after the line number if the line is too long.

If CLEN is less than SLEN, CHANGE branches to MOVDWN. Part of the BASIC-in-ROM line delete routine is paraphrased in MOVDWN, then DELETE is called to move the BASIC lines down and delete the extra bytes in the program. REPLAC is called to insert the change string. CHAIN rechains the BASIC line pointers. RETURN resets the BASIC workspace index (ORIGIN) and jumps back into the search loop.

Developing SURCHANGE was a real challenge. Many thanks to Earl Morris for advice and for finding the bugs in the program.

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ON ERROR GOTO for OSI ROM BASIC

by Earl Morris and Kerry Lourash

This run-time utility allows you to trap certain non-fatal errors and continue your program execution. You can also print out full error descriptions.

ON ERR
requires:
OSI C1P or 540-based computer

When OSI ROM BASIC encounters an error, program execution is halted and the screen displays the dreaded

? S* ERROR IN LINE xx

where the * is a graphics character rather than the correct letter. The following programs add an "ON ERR GOTO" function to your machine so that errors are detected and a jump is made to program line 50000. The line number where the error occurred is stored in the variable XX and the type of error is stored in X. At line 50000, the programmer can print out the expanded error message, fix the error, or jump back to the program. As an added bonus, the graphics character in the error message is converted to the correct alphabetic letter.

As an example, consider the program

```
10 INPUT "NUMBER"; A
20 PRINT:PRINT 1/A
30 GOTO 10
```

If a zero is input, the program will halt with a divide-by-zero error in line 20. With the error trap program in place, the following can be added:

```
50000 PRINT: IF XX < > 20 THEN END
50010 PRINT:PRINT "CAN'T DIVIDE
  BY ZERO — TRY AGAIN"
50020 GOTO 10
```

If an error occurs in line 20, the error trap program will print a message and continue program execution. Other errors will still end the program. The error trap resets the stack, effectively clearing all loops and subroutines. The jump back to the main program cannot enter within a FOR-NEXT loop or go directly to a subroutine.

Two versions of the ON ERR routine are listed: 1P and 540. Use the version appropriate for your machine. The method used to detect errors is different for each type of computer. The 1P version uses the output vector on page two. On every carriage return, the ON ERR program searches the stack to determine which routine is writing to the screen. If an $A252 is found on the stack, then the error routine is outputting and the ON ERRor program is triggered.

```
                       ;     *********************************
                       ;     * ON ERROR routine for 540 video *
                       ;     *********************************
                       ;
                       ;       Goes to line 50000 on error
                       ;       with line number in XX.
                       ;
                       ;       set-up  $0004=$40  $0005=$02
                       ;
0240                   *=$0240
0240 48                PHA
0241 AD40D7            LDA $D740       READ SCREEN
0244 C93F              CMP #$3F        QUESTION MARK ?
0246 F004              BEQ J1          IF YES THEN ERROR OCCURED
0248 68        J2      PLA             NORMAL MESSAGE OUTPUT
0249 4CC3A8            JMP $A8C3       MESSAGE PRINTER
024C AD42D7    J1      LDA $D742       FIX GRAPHICS CHARACTER
024F 297F              AND #$7F        REMOVE HIGH BIT
0251 8D42D7            STA $D742       STORE ON SCREEN
0254 A588              LDA $88
0256 C9FF              CMP #$FF        IMMED MODE ?
0258 F0EE              BEQ J2          IF YES- GO TO BASIC
025A 68                PLA
025B A487              LDY $87         CURRENT LINE #
025D 84AE              STY $AE         TO $AD.$AE
025F A588              LDA $88
0261 85AD              STA $AD
0263 A290              LDX #$90
0265 38                SEC
0266 20E8B7            JSR $B7E8       CONVERT HEX TO FLOATING
0269 A900              LDA #$00
026B 855E              STA $5E
026D 855F              STA $5F
026F A958              LDA #$58        $58 = "X"
0271 8593              STA $93
0273 8594              STA $94
0275 2049AD            JSR $AD49       FIND OR CREATE XX VARIABLE
0278 8597              STA $97
027A 8498              STY $98
027C 2074B7            JSR $B774       PUT VALUE INTO XX
027F A950              LDA #$50        HEX  50000 INTO $11.$12
0281 8511              STA $11
0283 A9C3              LDA #$C3
0285 8512              STA $12
0287 2032A4            JSR $A432       FIND LINE 50000
028A 9006              BCC J3
028C 20D9A6            JSR $A6D9       POINT TO LINE 50000
028F 4CC2A5            JMP $A5C2       BASIC EXECUTION LOOP
0292 A992      J3      LDA #$92        NO LINE 50000- PRINT "OK"
0294 A0A1              LDY #$A1
0296 4CC3A8            JMP $A8C3       MESSAGE PRINTER
```

Machines other than the 1P do not have the output vector in RAM, and must use a different hook into BASIC. The ON ERR program hooks into the OK message printer at $0003. The routine looks for the "?" which appears above the OK whenever an error occurs. A disadvantage of this hook is that the normal error message has already been printed and the type of error is no longer in memory. Thus the 540 version stores a value in XX (line number) but not in X (error type).

In both programs, after an error is detected, location $88 is inspected. If it contains a $FF, the computer is in the immediate mode and the ON ERRor routine is bypassed. Then the normal error message (corrected) is printed. If you wish to use ON ERRor in the immediate mode, change the following location:

1P — Change $0243 from $4C to $00
540 — Change $0259 from $EE to $00

The variable XX will contain 65xxx as a line number if the error occurs in the immediate mode.

If the computer is not in immediate mode, or if the above patch is made, the current line number is converted to

```
                   ;  **********************************
                   ;  *  ON ERROR routine, 1P version  *
                   ;  **********************************
                   ;
                   ;   Goes to line 50000 on error with
                   ;   line number in XX, error type in X.
                   ;
                   ;   Set up $021A=$22,  $021B=$02
                   ;
     0222                 *=$0222
                   ;
     0222 C90D              CMP  #$0D      ;OUTPUT=CR?
     0224 D015              BNE  BYE       ;NO, EXIT
     0226 8A                TXA            ;SAVE X REGISTER
     0227 48                PHA
     0228 BA                TSX            ;GET STACK POINTER
     0229 BD0601            LDA  $106,X    ;IS CALLING ADDRESS
     022C C952              CMP  #$52      ;$A252 ?
     022E D007              BNE  A1
     0230 BD0701            LDA  $107,X
     0233 C9A2              CMP  #$A2
     0235 F007              BEQ  ERRTRP    ;YES, TO ERR TRAP
     0237 68         A1     PLA            ;RESTORE X REG.
     0238 AA                TAX
     0239 A90D              LDA  #$0D      ;RESTORE A-REG.
     023B 4C69FF     BYE    JMP  $FF69     ;GOTO REG. OUTPUT
                     ;
     023E A588       ERRTRP LDA  $88       ;IF IN IMM. MODE
     0240 C9FF              CMP  #$FF      ;PRINT ERR MESSAGE
     0242 F04C              BEQ  ERROR
                                           ;STORE CURRENT LINE # IN XX
     0244 A487              LDY  $87       ;CURRENT LINE #
     0246 85AD              STA  $AD       ;TO F.P.A
     0248 84AE              STY  $AE
     024A A290              LDX  #$90
     024C 38                SEC
     024D 20E8B7            JSR  $B7E8
     0250 A900              LDA  #0        ;FIND OR CREATE XX
     0252 855E              STA  $5E
     0254 855F              STA  $5F
     0256 A958              LDA  #$58
     0258 8593              STA  $93
     025A 8594              STA  $94
     025C 2049AD            JSR  $AD49
     025F 8597              STA  $97       ;STORE F.P.A IN XX
     0261 8498              STY  $98
     0263 2074B7            JSR  $B774
                                           ;STORE ERROR #/2 IN X
     0266 68                PLA            ;PULL ERROR #
     0267 48                PHA
     0268 4A                LSR  A         ;HALVE IT
     0269 A8                TAY            ;STORE ERR # IN F.P.A
     026A A900              LDA  #0
     026C 20C1AF            JSR  $AFC1

     026F A900              LDA  #0        ;FIND OR CREATE X
     0271 8594              STA  $94
     0273 2049AD            JSR  $AD49
     0276 8597              STA  $97       ;STORE F.P.A IN X
     0278 8498              STY  $98
     027A 2074B7            JSR  $B774
                                           ;FIND LINE 50000
     027D A950              LDA  #$50      ;HEX 50000 IN $11,12
     027F 8511              STA  $11
     0281 A9C3              LDA  #$C3
     0283 8512              STA  $12
     0285 2032A4            JSR  $A432
     0288 9006              BCC  ERROR     ;BRANCH IF NO LINE
     028A 20D9A6            JSR  $A6D9     ;SET PARSER AT 50000
     028D 4CC2A5            JMP  $A5C2     ;BASIC EXEC. LOOP
                                           ;PRINT ERR MESSAGE
     0290 68         ERROR  PLA            ;PULL ERR INDEX
     0291 AA                TAX
     0292 20E3A8            JSR  $A8E3     ;PRINT '?'
     0295 BD64A1            LDA  $A164,X   ;FIRST LETTER
     0298 20E5A8            JSR  $A8E5     ;PRINT IT
     029B BD65A1            LDA  $A165,X   ;SECOND LETTER
     029E 297F              AND  #$7F      ;ZERO HI BIT
     02A0 4C5FA2            JMP  $A25F     ;TO REG. ERR ROUTINE
```

Table 1

Index	Error Message
0	Next Without For
1	Syntax Error
2	Return Without Gosub
3	Out Of Data
4	Function Call — argument out of range
5	Overflow
6	Out Of Memory
7	Undefined Statement GOTO non-existent line
8	Bad Subscript Subscript greater than dimension
9	Double Dimension
10	Division By Zero
11	Illegal Direct Can't use in immediate mode
12	Type Mismatch
13	Long String
14	String Temporaries
15	Continue Error
16	Undefined Function

floating point and stored in the variable XX. The error index contained in the X register is halved, converted to floating point, and stored in the variable X.

Next a search is made for line 50000. If it is found, the parser pointer is set to the start of line 50000 and the program jumps to the start of the BASIC execution loop. If no line 50000 is found, the normal error message is output and execution is halted.

Notes on 1P Version

Whenever the BREAK key is pressed, the 1P's vectors are reset to the original. The output vector again must be pointed to ON ERRor after every break. This can also be done with

```
POKE 538,34 : POKE 539,2
```

For the 1P version, the error type is contained in the variable X. Table 1 lists the error types. A program can be written to print out the full error descriptions if you have trouble remembering what "T*" means.

Notes on 540 Version

On error can also be set up using

```
POKE 4,64 : POKE 5,2
```

The first command in line 50000 should be PRINT. This scrolls the error message up one line to prevent retriggering ON ERRor. The 540 version does not put the error type into X, but the error type is displayed on the screen at $D741 and $D742. The ON ERRor program could be extended to read these locations and do a table look-up to get the error index.

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MICRO

It's All 1's and 0's

American Gumby Corporation
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Epstein-Barr, NJ 11235

New Product Announcement: 7903 MPU with Enhanced Instruction Set

The new 7903 MPU provides a plug-in upgrade for systems currently using the 6502 microprocessor. The 7903 is fully pin-compatible and software upward-compatible with the 6502. Additionally, many of the formerly unused opcodes are used to provide an enhanced instruction set providing features normally found only on much larger systems. The new instructions are listed below.

BBI	Branch on Blinking Indicator
BH	Branch and Hang
BCBF	Branch on Chip Box Full
BPO	Branch on Power Off
BSO	Branch on Sleepy Operator
IIB	Ignore Inquiry and Branch
RPB	Reverse Parity and Branch
BCH	Branch on CPU Halted
BTAD	Branch To Auto-Destruct
JRL	Jump to Random Location
JSP	Jump on Sexy Programmer
FAG	Fold And Go
AI	Add Improper
DO	Divide and Overflow
DC	Divide and Conquer
SRZ	Subtract and Reset to Zero
ARZ	Add and Reset to Zero
XM	Exclusive Maybe
PAII	Prevent All Interrupts and Interrupt
PI	Punch Invalid
RI	Read Invalid
RCSD	Read Card and Scramble Data
RCR	Rewind Card Reader
RASC	Read And Shred Card
BCR	Backspace Card Reader
BCP	Backspace Card Punch
RCI	Read Card and Ignore
RCS	Read Card Sideways
SSJ	Select Stacker and Jam
RP	Read Printer
FSRR	Forms Skip and Run Away
BSP	BackSpace Printer
PBC	Print and Break Chain
TDB	Transfer and Drop Bits
MDB	Move and Drop Bits
MLR	Move and Lose Record
MWC	Move and Wrap Core
MC	Move Continuous
CM	Circulate Memory
WWLR	Write Wrong Length Record
RNR	Read Noise Record
RIRG	Read Inter-Record Gap
REOF	Read End-Of-File .
BST	Backspace and Stretch Tape
RBT	Rewind and Break Tape
MTI	Make Tape Invalid
PMT	Punch Magnetic Tape
PDT	Punch and Delete Tape
MET	Misread and Eat Tape
PTAB	Position Tape Ass-Backwards
STT	Stretch and Tangle Tape
ST	Scratch Tape
SRSD	Seek Record and Scar Disk
RD	Rewind Disk
BD	Backspace Disk
ED	Eject Disk
TD	Throw Disk
LCD	Launch Cartridge Disk
FD	Flip Disk
DF	Disk Feed
UER	Update and Erase Record
CVU	ConVert to Unary
CVS	ConVert to Sesquinary
CRN	Convert to Roman Numerals
WRTC	Wind Real-Time Clock
WWTC	Wind Wrong-Time Clock
PCB	Pause for Coffee Break
SPD	Start and Power Down
PDN	Power Down and Normalize
EBQR	Enable Bi-Quinary Arithmetic
LCC	Load and Clear Core
EROS	Erase Read-Only Store
RWOM	Read Write-Only Memory
WROM	Write Read-Only Memory
FCE	Fill Core with Epoxy
DMPK	Destroy Memory Protect Key
UC	Unwind Core
BPP	Blob Plotter Pen
MPS	Move Pen Somewhere
DPMD	Drop Pen and Mangle Drum
APX	Apply Power and Explode
HCF	Halt and Catch Fire
CCP	Clear Core and Proceed
CCCP	Conditionally Clear Core and Proceed
EIOC	Execute Invalid Op Code
EPI	Execute Programmer Immediate
SPSW	Scramble Program Status Word
ERAF	Execute Relocatable Address Field
EPSW	Execute Program Status Word
EM	EMulate 407
SSN	Set Serial Number
STI	STore Immediate
PSP	Push Stack Pointer

Straightforward Garbage Collection for the Apple

by Cornelis Bongers

This article presents a method of garbage collection that dramatically increases program efficiency by eliminating lengthy delays caused by string processing.

Memory Organizer
requires:
Apple II or Apple II Plus with Applesoft in ROM or language card

Introduction

When processing large amounts of alphanumeric data in Applesoft (or another Microsoft BASIC) by means of strings and string operations, you will be confronted with one of Applesoft's weakest points: garbage collection. A program that runs perfectly may suddenly come to a grinding halt. Depending on the number of active strings in memory, you could be put out of business for a few tenths of a second or half an hour. Consider, for instance, the following simple program:

GARBAGE TEST on 48K Apple with DOS (HIMEM:$9600)

```
10 DIM A$(4600)
20 FOR I = 1 TO 4600
30 PRINT I
40 A$(I) = "$" + STR$(I)
50 NEXT
60 PRINT CHR$(7);" READY
   (AT LAST)"
```

This program runs fine until I becomes equal to 2740. At that point, the regular printing of I stops for 13 minutes, after which it continues again until I becomes 3835. This time you will have to wait for 20 mintues before the printing restarts.

In total, the time needed to finish the program is 84 minutes. Only three minutes (or 3.5%) are spent on the actual execution of the program. The remaining time is consumed by Applesoft's garbage collection routine. A question that may arise at this point is: What is meant by garbage and why is garbage collection necessary? To answer this question, consider the following program segments:

```
1000 GOSUB 5000: REM INPUT
     NAME AND CHECK NAME
1010 B$(I) = A$
1020 .....
.
.
.
5000 INPUT "GIVE NAME OF
     ITEM ";A$
5010 ....CHECK INPUT ....
.
.
.
5200 RETURN
```

When a new item has to be added to the list in B$, the subroutine at line 5000 is called, then asks for a name and checks whether this name satisfies some conditions (not listed here). At each new input the text that has been input is added to the stringpool and a pointer to this text is inserted in (the space reserved for) A$. The variable A$ itself is treated in the same way as a numeric variable and resides therefore in the variable space. There are seven bytes reserved for A$. The first two bytes contain the hex values 41 and 80, which represent the name. The next three bytes form the string descriptor and the last two bytes are unused. The string descriptor contains the length of the text (string) that has been input in A$ and the pointer to the string, in that order. So, if the text 'lens' is input, a snapshot of memory may look as displayed in figure 1.

If the checking in the subroutine is done, control returns to the main program and the assignment at line 1010 is executed. The target of the assignment is an array element. As in the case of simple variables (like A$), room is reserved for each array element. However, only the three bytes of the descriptor are reserved for each element of a string array. At the assignment, the top of free memory (i.e., the start of the stringpool) is decreased by four and the text 'lens' is copied to the area between the 'old' top and the 'new' top. Consequently, the text 'lens' now occurs twice in the stringpool (see figure 2).

Now, if line 5000 is executed later in the program, A$ gets a new value, say 'shutter'. This text is again added to the stringpool in the way described above and the pointer in the descriptor of A$ is set to the new top. The previous value of A$, i.e. 'lens', has now become non-active, since none of the pointers in the descriptors point to it. In other words, the text 'lens' that was related to A$ is of no use anymore and it is therefore called garbage.

Apart from assignment statements, garbage may also be generated if you make use of string expressions. In the first program listed above, where a string expression occurs at line 40, the stringpool will be filled with the strings, $1,$2,..., etc. But between every two strings, there is some garbage. For instance, after executing the I loop 10 times, the stringpool looks like this:

<u>$10</u>10<u>$9</u>9<u>$8</u>8<u>$7</u>7<u>$6</u>6<u>$5</u>5<u>$4</u>4<u>$3</u>3<u>$2</u>2<u>$1</u>1

Only the underlined strings are active because they are referred to by the descriptors in the A$ array. If the I loop has been executed 2740 times, the stringpool occupies all the memory up to the top of the array space, and at that time Applesoft takes action. It knows that garbage is likely to be present in the stringpool and therefore it starts reorganizing the stringpool, eliminating the non-active strings. This reorganization process works as follows:

A complete pass is made through the variable and the array space. In this

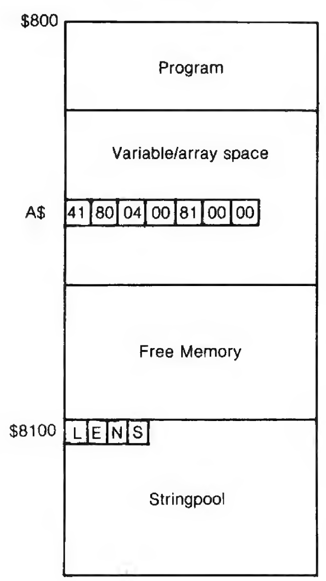

Figure 1

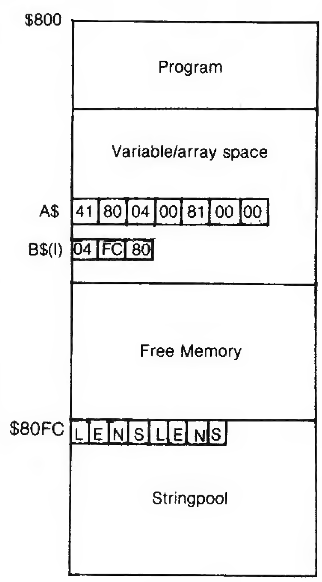

Figure 2

pass all string descriptors are examined with the purpose of finding the pointer to the highest string in the stringpool (i.e., the string nearest to HIMEM). The string that this pointer references is moved up to the top of memory and the descriptor of this string is appropriately adjusted. Next, a second pass is made through the variable and array space; now the next-but-highest pointer is searched for. The string pointed to is then moved to just below the string that was moved up during the previous pass. This process continues until all the active strings reside in a compact block that is located just below HIMEM. Then the pointer to the start of the stringpool is adjusted. Since all the garbage now has been eliminated, there will be sufficient free memory to continue the execution of the program.

The time needed to collect garbage with this method varies approximately quadratically with the number (n) of active strings in memory. This is due to the fact that Applesoft has to make n passes through the variable/array space and each pass consists of n comparisons and some other operations. Consequently, the total time needed is proportional to n*n. Thus if you have an array of 1000 active strings and you fill another array with 1000 strings, garbage collection will not last twice as long, but four times as long.

It is mainly the quadratic character of Applesoft's garbage collection routine that causes the long execution times if there are many active strings in memory (see table 1). Therefore, the best way to cut down execution time is to design a garbage collection method whose execution time varies linearly, rather than quadratically, with the number of active strings. Another way to speed up garbage collection, which may be used in combination with the first, is to clear (erase) all string arrays as soon as their contents are not needed anymore. This effectively reduces the number of active strings and therefore also the time to collect garbage.

The program listed in figure 3 contains a linear garbage collection routine and a selective array eraser.

How It Works

Basically the problem with garbage collection is that there are only pointers from variables and array elements to the strings and not the other way around. Thus when looking in the stringpool one can view the strings, but it is impossible to say to which variable/array element they belong or whether they are active or non-active (garbage). If somehow the strings themselves would indicate whether they are active or non-active and to which variable/array element they belonged, garbage collection would become a simple matter. Just move up all the active strings one by one to the current top of free memory and adjust for each string the pointer in the descriptor. Note that it is necessary to retrieve the length of the string from the descriptor before the move is done, since this length is used at the execution of the move.

We now have the interesting question: is it possible to store (temporarily) the necessary information (mentioned above) in the strings themselves? Of course this must happen under the condition that no extra memory space is used, since lack of memory is just what triggered FRE(0). However, the storage of information will require memory. But let us first consider how much memory exactly is required. Suppose first that all strings in the pool have a length of at least three bytes. By making a pass through the variable and array space, we can successively store the active/non-active marker and the pointer to the descriptor in each string. The insertion of the active/non-active marker does

***Table 1:* Execution times (in seconds) of garbage collection routines as a function of the number of active strings in memory.**

No. of Active Strings	Applesoft(1)	'Linear' Method(1)	'Linear' Method(2)
100	1	0.05	0.06
250	5	0.11	0.14
500	19	0.21	0.26
1000	75	0.42	0.52
2000	292	0.84	1.04
3000	655	1.26	1.53
4000	1154	1.68	2.04
5000	1811	2.10	2.55

(1) All strings are of length 3.
(2) One string is of length 2, the others are of length 3.

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Figure 3

```
                 ;************************
                 ;*                      *
                 ;*  MEMORY ORGANIZER I  *
                 ;*          BY          *
                 ;*   CORNELIS BONGERS   *
                 ;*                      *
                 ;*      ORGANIZER       *
                 ;*                      *
                 ;*                      *
                 ;*                      *
                 ;*                      *
                 ;*                      *
                 ;*                      *
                 ;************************
                 ;
                          ORG $9000
                          OBJ $800
                 ;
                 LEN      EPZ $06           ;LENGTH STRING
                 STAT     EPZ $07           ;ARRAY/VAR OFFSET
                 SDES     EPZ $08           ;POINTER TO STRING
                                             VARIABLE/ARRAY EL.
                 RCHK     EPZ $17           ;RESULT MEMORY CHECK
                 A1L      EPZ $3C           ;MONITOR MOVE REGISTERS
                 A2L      EPZ $3E           ;     "       "       "
                 A4L      EPZ $42           ;     "       "       "
                 VARS     EPZ $69           ;START VARIABLE SPACE
                 ARS      EPZ $6B           ;START ARRAY SPACE
                 EARS     EPZ $6D           ;END ARRAY SPACE
                 SPOOL    EPZ $6F           ;START STRING POOL
                 HIM      EPZ $73           ;HIMEM
                 SARA     EPZ $9B           ;POINTER TO START ARRAY
                 SPTR     EPZ $9D           ;POINTER TO STRING
                 ARP      EPZ $9F           ;POINTER TO NEXT ARRAY
                 DO3      EPZ $A1           ;3RD STEP FLAG
                 EPROG    EPZ $AF           ;POINTER TO END OF PROGRAM
                 SDES1    EPZ $FC           ;POINTER TO STRING DESCRIPTOR
                 TOP      EPZ $FE           ;START OF (NEW) STRING POOL
                 ;
                 ; ** BASIC AND MONITOR ROUTINES **
                 ;
                 MOVE     EQU $FE2C         ;MONITOR MOVE ROUTINE
                 GNAME    EQU $F7D9         ;EVALUATE ARRAY NAME
                 NAME     EQU $DFE3         ;EVALUATE VARIABLE
                 PLET     EQU $DA63         ;PART OF BASIC'S LET
                 CTYP     EQU $DD6A         ;CHECK ON NUMERIC
                 FREO     EQU $E2E8         ;PART OF BASIC'S FRE(0)
                 ITOO     EQU $E84E         ;INIT MFP TO 0
                 CKOL     EQU $DEBB         ;CHECK ON '('
                 CKOR     EQU $DEB8         ;CHECK ON ')'
                 SYN      EQU $DEC9         ;SYNTAX ERROR
                 CHNW     EPZ $B1           ;GET NEXT CHARACTER
                 CHOL     EPZ $B7           ;GET CURRENT CHARACTER
                 ;
                 ; ** TOKENS AND SPECIAL CHARACTERS **
                 ;
                 FRE      EPZ $D6           ;TOKEN FOR FRE
                 MIN      EPZ $C9           ;TOKEN FOR -
                 CLEAR    EPZ $BD           ;TOKEN FOR CLEAR
                 COM      EPZ $2C           ;COMMA
                 BJP      EQU $3F5          ;& VECTOR
                 ;
9000             ; ** INITIALIZATION **
9000             ;
9000 A9 13       BEGIN    LDA #START
9002 8D F6 03             STA BJP+1         ;SET & VECTOR
9005 A9 90                LDA /START
9007 8D F7 03             STA BJP+2
900A A9 00                LDA #BEGIN
900C 85 73                STA HIM           ;SET HIMEM
900E A9 90                LDA /BEGIN
9010 85 74                STA HIM+1
9012 60                   RTS

9013             ;
9013             ; ** ERASE ARRAYS **
9013             ;
9013 C9 BD       START    CMP #CLEAR        ;TOKEN FOR CLEAR?
9015 D0 35                BNE START1        ;NO,CHECK ON FRE
9017 20 B1 00    NXAR     JSR CHNW          ;ADVANCE TEXTPOINTER
901A 20 D9 F7             JSR GNAME         ;EVALUATE ARRAY NAME
901D 18                   CLC
901E A0 01                LDY #$01
9020 A2 FE                LDX #$FE
9022 B5 6F       DOAG     LDA EARS+2,X      ;SET UP POINTER TO
9024 95 40                STA A2L+2,X       ;END OF MOVE AREA
9026 B5 9D                LDA SARA+2,X      ;SET UP POINTER TO
```

(Continued)

not lead to problems because all characters have their high bit off when processing strings in the normal way. A string can thus be marked active by setting the first bit of a character in that string. The pointer to the descriptor requires two bytes and these can be substituted for two characters. Thus, if A$ equals 'MARJO', the stringpool contains somewhere the values 4D, 41, 52, 4A, and 4F. By making a pass through the variable/array space, A$ will be encountered and the string in the pool can be adjusted to 23, 0A, D2, 4A, and 4F. As can be seen, the third byte now has its high bit on, whereas the address of the descriptor is stored in the first and second bytes. (It is assumed that A$ resides at $A21). The only problem left is where to store the two characters M and A, which have been replaced by the address of the descriptor. The obvious answer is: store them in the descriptor of A$. This descriptor contains the pointer to the string 'MARJO' or what is left of it, but this pointer is not needed anymore, once the string is located.

Having applied this operation to all strings, a pass through the stringpool is made. We start at HIMEM and search down until a character with its first bit on is encountered. This character must belong to an active string and the address of the descriptor will be stored in the next two bytes. First the length of the string and its two characters are retrieved from the descriptor. Next the two characters are restored in the string and the string is moved up as far as possible. Finally, the new starting position of the string is stored in the descriptor. Then the next string is searched for and this process continues until the start of the (old) stringpool is reached.

The remaining problem is: what to do with strings whose length equals 1 or 2? Clearly, these strings are too short to allow us to store the necessary information in them. Again the answer is not difficult. Just copy the whole string in the descriptor and forget about the string in the pool (it will thus not be marked active). The descriptor occupies three bytes. One of these bytes will be needed to flag that the descriptor itself contains the string. For this purpose the high address byte of the pointer can be used by setting it to FF if a string is stored in the descriptor. Note that the high byte cannot equal FF during normal operations because this would mean that the string resides in the Monitor. If the length of a string equals 2, the remaining two bytes of the descriptor can be used to store the character. If the length equals 1, the string is put in the first byte of the

descriptor and the second byte is put equal to FF. Note that here again use is made of the fact that during normal operations all characters in the stringpool have their high bit off.

If strings with length 1 or 2 are present in the stringpool, it will be necessary to make a second pass through the variable/array space (after the pass through the stringpool). During this pass all strings that were stored in the descriptors are replaced in the stringpool and the pointers to these strings are inserted in the descriptors.

Table 1 shows the performance of the method outlined above. As can be seen, there exists, apart from some small measurement errors, a linear relationship between the number of active strings and the execution time. The fourth column of the table shows that the extra pass, which is necessary if the stringpool contains strings with a length less than 3, increases the execution time by about 20%.

The differences in execution time between Applesoft's garbage collection routine and the 'linear' garbage collection routine are considerable. For instance, if garbage collection is done when, say, 1000 active strings reside in memory (in an array), a speed improvement with a factor of 75/0.52 = 144 can be realized. When doubling the number of active strings, this factor doubles (approximately) too. So, with 4000 active strings, the speed improvement is about a factor of 4*144 = 576.

However, it should be noted that the speed improvement reduces if the (average) length of the strings increases. For instance, if there are 999 active strings of length 15 and one of length 1, the time gain is about a factor of 80. For 1999 active strings of length 15 and one of length 1, it is about a factor of 160.

The Program

The machine language program, listed in figure 3, is linked to BASIC by means of the & statement. The syntax of the statement for this program is

& FRE ([–] digit
[,name of numeric variable])

or

& CLEAR arrayname
[(,arrayname)]

As indicated by the keyword FRE, the first &-line handles the garbage collection. Contrary to Applesoft's

Figure 3 *(Continued)*

```
9028 95 44                 STA A4L+2,X        ;TARGET OF MOVE AREA
902A C8                    INY
902B B1 9B                 LDA (SARA),Y
902D 75 9D                 ADC SARA+2,X       ;SET UP POINTER TO
902F 95 3E                 STA A1L+2,X        ;START OF MOVE AREA
9031 E8                    INX
9032 D0 EE                 BNE DOAG           ;EXECUTE LOOP TWICE
9034 A0 00                 LDY #$00           ;Y MUST BE ZERO ON ENTRY MOVE
9036 20 2C FE              JSR MOVE           ;EXECUTE MOVE
9039 18                    CLC
903A CA                    DEX                ;X=FF
903B B5 43        DOAG1    LDA A4L+1,X        ;ADJUST POINTER TO
903D E9 00                 SBC #$00           ;END ARRAY SPACE
903F 95 6E                 STA EARS+1,X
9041 E8                    INX
9042 F0 F7                 BEQ DOAG1          ;EXECUTE LOOP TWICE
9044 20 B7 00              JSR CHOL           ;GET CURRENT CHARACTER
9047 C9 2C                 CMP #COM           ;IS IT A COMMA?
9049 F0 CC                 BEQ NXAR           ;ERASE NEXT ARRAY IF SO
904B 60                    RTS                ;RETURN TO BASIC


904C              ;
904C              ; ** DRIVER FRE ROUTINE **
904C              ;
904C C9 D6        START1   CMP #FRE           ;TOKEN FOR FRE?
904E F0 03                 BEQ NSYN           ;BRANCH IF SO
9050 4C C9 DE              JMP SYN            ;ELSE SYNTAX ERROR
9053 4A           NSYN     LSR                ;CLEAR FIRST BIT
9054 85 17                 STA RCHK           ;SET UP CHECK REGISTER
9056 20 B1 00              JSR CHNW           ;GET NEXT CHAR
9059 20 BB DE              JSR CKOL           ;CHECK '('
905C C9 C9                 CMP #MIN           ;MINUS?
905E D0 08                 BNE FREAM          ;BRANCH IF NOT
9060 20 21 92              JSR CHECK          ;CHECK MEMORY ON NEG ASCII'S
9063 66 17                 ROR RCHK           ;SAVE RESULT CHECK
9065 20 B1 00              JSR CHNW           ;GET DIGIT
9068 29 0F        FREAM    AND #$0F
906A F0 0B                 BEQ DOFRE1         ;DO IT ALWAYS IF 0
906C 18                    CLC
906D 65 6E                 ADC EARS+1
906F A6 6D                 LDX EARS           ;IS EARS+DIGIT*256<SPOOL?
9071 E4 6F                 CPX SPOOL
9073 E5 70                 SBC SPOOL+1
9075 90 07                 BCC NOFRE          ;YES, DON'T DO IT
9077 A5 17        DOFRE1   LDA RCHK           ;CHECK OK?
9079 30 03                 BMI NOFRE          ;NO, DON'T DO IT
907B 20 A4 90              JSR DOFRE          ;COLLECT GARBAGE
907E 20 B1 00     NOFRE    JSR CHNW           ;GET NEXT CHARACTER
9081 C9 2C                 CMP #COM           ;IS IT A COMMA
9083 D0 1C                 BNE HAAK           ;BRANCH IF NOT
9085 20 B1 00              JSR CHNW           ;GET NEXT CHARACTER
9088 20 E3 DF              JSR NAME           ;EVALUATE NAME
908B 85 85                 STA $85
908D 84 86                 STY $86            ;SAVE POINTER FOR LET
908F 20 6A DD              JSR CTYP           ;MUST NOT BE A STRING
9092 20 E8 E2              JSR FREO           ;CALCULATE FREE MEMORY
9095 A5 17                 LDA RCHK
9097 10 03                 BPL NZER           ;BRANCH IF TEST OK
9099 20 4E E8              JSR ITOO           ;ELSE SET MFP TO 0
909C A5 12        NZER     LDA $12            ;LOAD TYPE VARIABLE
909E 20 63 DA              JSR PLET           ;SIMULATE A LET
90A1 4C B8 DE     HAAK     JMP CKOR           ;RETURN TO BASIC


90A4              ;
90A4              ; ** COLLECT GARBAGE **
90A4              ;
90A4              ; ** STEP 1: PUT POINTERS IN STRINGS **
90A4              ;
90A4 85 A1        DOFRE    STA DO3            ;INIT STEP 3 FLAG TO <> 0
90A6 20 6E 91              JSR INITS          ;SET POINTERS FOR NOSTR
90A9 20 80 91     GNXST    JSR NOSTR          ;SEARCH NEXT STRING
90AC B0 3B                 BCS STEP2          ;BRANCH IF NO MORE STRINGS
90AE E4 AF                 CPX EPROG          ;STRING IN PROGRAM?
90B0 E5 B0                 SBC EPROG+1
90B2 90 F5                 BCC GNXST          ;DON'T PROCESS IT IF SO
90B4 A6 06                 LDX LEN
90B6 F0 F1                 BEQ GNXST          ;NEGLECT IF LENGTH=0
90B8 E0 03                 CPX #$03
90BA 90 14                 BCC APART          ;BRANCH IF LENGTH EQUALS 1 OR
2
90BC B1 9D                 LDA (SPTR),Y       ;Y=2 ON EXIT NOSTR
90BE 09 80                 ORA #$80           ;SET 1ST BIT OF 3RD CHAR
90C0 91 9D        P2C      STA (SPTR),Y
90C2 88                    DEY
90C3 30 E4                 BMI GNXST
90C5 B1 9D                 LDA (SPTR),Y       ;PUT FIRST 2 CHARS
90C7 C8                    INY                ;IN FIRST 2 BYTES OF DESC.
90C8 91 FC                 STA (SDES1),Y
```

(Continued)

Figure 3 *(Continued)*

```
90CA 88                   DEY
90CB B9 FC 00             LDA SDES1,Y        ;PUT ADDRESS DESC. IN STRING
90CE B0 F0                BCS P2C            ;ALWAYS
90D0 A0 00      APART     LDY #$00
90D2 84 A1                STY DO3            ;STEP 3 MUST BE DONE
90D4 B1 9D                LDA (SPTR),Y       ;PUT FIRST CHAR IN
90D6 91 FC                STA (SDES1),Y      ;LENGTH BYTE OF DESC.
90D8 A9 FF                LDA #$FF           ;PUT FF IN 2ND BYTE DESC.
90DA C8                   INY                ;IF LENGTH EQUALS 1
90DB CA                   DEX
90DC F0 02                BEQ AFF
90DE B1 9D                LDA (SPTR),Y       ;PUT 2ND CHAR IN 2ND BYTE
90E0 91 FC      AFF       STA (SDES1),Y      ;OF DESC. IF LENGTH EQUALS 2
90E2 C8                   INY
90E3 A9 FF                LDA #$FF           ;PUT 3RD BYTE OF DESC.
90E5 91 FC                STA (SDES1),Y      ;EQUAL TO FF
90E7 30 C0                BMI GNXST          ;ALWAYS

90E9            ;
90E9            ; ** STEP 2: MOVE STRINGS UP **
90E9            ;
90E9 20 21 92   STEP2     JSR CHECK          ;SEARCH NEG ASCII'S
90EC 4C F2 90             JMP CON
90EF 20 2E 92   ESTEP2    JSR DEYY           ;CONTINUE SEARCH
90F2 90 3E      CON       BCC STEP3          ;FOUND NONE IF CARRY CLEAR
90F4 A0 02                LDY #$02

90F6 29 7F                AND #$7F           ;CLEAR 1ST BIT OF CHAR
90F8 91 9D                STA (SPTR),Y       ;AND RESTORE CHAR
90FA 88                   DEY
90FB B1 9D                LDA (SPTR),Y       ;NOW GET ADDRESS OF
90FD 85 09                STA SDES+1         ;OF DESCRIPTOR AND SAVE
90FF 88                   DEY                ;IT IN SDES
9100 B1 9D                LDA (SPTR),Y
9102 85 08                STA SDES
9104 B1 08                LDA (SDES),Y       ;GET LENGTH STRING
9106 85 06                STA LEN            ;AND SAVE IT
9108 C8                   INY
9109 B1 08                LDA (SDES),Y
910B 88                   DEY                ;GET 1ST CHAR OF STRING
910C 91 9D                STA (SPTR),Y       ;AND RESTORE IT
910E A0 02                LDY #$02
9110 B1 08                LDA (SDES),Y       ;GET 2ND CHAR OF STRING
9112 88                   DEY                ;AND RESTORE IT
9113 91 9D                STA (SPTR),Y
9115 A5 FE                LDA TOP            ;CARRY IS SET
9117 E5 06                SBC LEN            ;CALCULATE NEW TOP OF
9119 85 FE                STA TOP            ;FREE MEMORY
911B B0 02                BCS NOADJ
911D C6 FF                DEC TOP+1
911F 91 08      NOADJ     STA (SDES),Y       ;STORE ADDRESS STRING
9121 A5 FF                LDA TOP+1          ;IN DESCRIPTOR
9123 C8                   INY
9124 91 08                STA (SDES),Y
9126 A4 06                LDY LEN
9128 88         MOV       DEY
9129 B1 9D                LDA (SPTR),Y       ;MOVE STRING TO NEW
912B 91 FE                STA (TOP),Y        ;LOCATION
912D 98                   TYA
912E D0 F8                BNE MOV
9130 F0 BD                BEQ ESTEP2         ;ALWAYS

9132            ;
9132            ; ** STEP 3: RESTORE STRINGS OF LENGTH 1 OR 2 **
9132            ;
9132 A5 A1      STEP3     LDA DO3            ;IS THIS STEP NECESSARY?
9134 D0 08                BNE OMIT           ;BRANCH IF NOT
9136 20 6E 91             JSR INITS          ;INIT FOR NOSTR
9139 20 80 91   GNX2      JSR NOSTR          ;SEARCH NEXT STRING
913C 90 09                BCC NOKL           ;BRANCH IF FOUND
913E A5 FE      OMIT      LDA TOP            ;ALMOST READY NOW
9140 85 6F                STA SPOOL          ;UPDATE STRING POOL POINTER
9142 A5 FF                LDA TOP+1
9144 85 70                STA SPOOL+1
9146 60                   RTS                ;RETURN TO DRIVER
9147 A2 01      NOKL      LDX #$01           ;NOSTR RETURNS WITH Y=2
9149 B1 FC                LDA (SDES1),Y      ;LENGTH STRING EQUAL TO 1 OR 2 ?

914B C9 FF                CMP #$FF
914D D0 EA                BNE GNX2           ;BRANCH IF NOT
914F 88                   DEY
9150 B1 FC                LDA (SDES1),Y      ;LOAD 2ND BYTE OF DESC.
9152 30 05                BMI NOCH+1         ;BRANCH IN IT IS NOT A CHAR
9154 E8                   INX                ;INCREMENT LENGTH COUNTER
9155 20 14 92             JSR INS            ;STORE 2ND CHAR IN STRING POOL

9158 24 88      NOCH      BIT $88            ;HIDDEN DEY INSTRUCION
915A B1 FC                LDA (SDES1),Y      ;LOAD 1ST CHARACTER
```

(Continued)

FRE(0), the arguments of the & FRE are significant. One of the reasons to include arguments in the & FRE statement is that the user must be able to prevent a regular Applesoft FRE(0) from happening. This can be done by giving the & FRE(digit) command. If digit = 0 garbage collection will always be done. If digit < > 0 garbage collection will be done only if less than digit*256 free bytes of memory remain. Thus, & FRE(4) leads only to garbage collection if the amount of free memory is less than 1K. In case no garbage collection is done, the execution time of the statement will be about 0.0004 seconds only. It is therefore advised to insert the & FRE (digit) statement frequently in your program (of course with digit < > 0) to make sure Applesoft doesn't get the chance to execute its own FRE(0).

If a variable is specified in the & FRE statement, the amount of free memory that is available after garbage collection will be assigned to it. Thus, & FRE(0,K):PRINT K prints the amount of free memory.

Finally, if a minus sign is specified before the digit, the whole stringpool will be checked on the occurrence of

characters which have their high bit on. As will be clear from the explanation in the previous section, the occurrence of such characters will lead to a terrible crash if an & FRE(0) is forced. However, & FRE(−0,K) leads to garbage collection only if all high bits are off. If characters are found which have their high bit on, this will be flagged by putting K equal to 0.

It will usually not be necessary to use the '−' option since under normal circumstances Applesoft will store all characters with their high bit off. However, in some programs statements of the type: A$ = CHR$(X) are used. For X > = 128 the execution of this statement will store 'characters' in the string pool with their high bit on. Therefore, if & FRE is implemented in a program in which 'high bit on' characters might occur, it is strongly advised to check the stringpool at the first execution of the & FRE statement. If one is sure there are 'no high bit on' characters, it is better to omit the check since it increases execution time.

The second &-line can be used to clear (erase) arrays. For instance, & CLEAR A, A$, A% clears the arrays A, A$, and A%. An array that is mentioned in the & CLEAR statement must have

Figure 3 *(Continued)*

```
915C 20 14 92          JSR INS           ;AND STORE IT IN POOL
915F 8A                TXA
9160 91 FC             STA (SDES1),Y     ;STORE LENGTH IN DESCRIPTOR
9162 C8                INY
9163 A5 FE             LDA TOP
9165 91 FC             STA (SDES1),Y     ;SAVE POINTER TO STRING
9167 C8                INY               ;IN DESCRIPTOR
9168 A5 FF             LDA TOP+1
916A 91 FC             STA (SDES1),Y
916C D0 CB             BNE GNX2          ;ALWAYS

916E           ;
916E           ; ** SET UP POINTERS FOR NOSTR **
916E           ;
916E A9 07     INITS   LDA #$07
9170 85 07             STA STAT          ;VARIABLES OFF SET
9172 38                SEC
9173 A5 69             LDA VARS
9175 E9 07             SBC #$07          ;SET SDES TO START OF
9177 85 08             STA SDES          ;VARIABLE SPACE-7
9179 A5 6A             LDA VARS+1
917B E9 00             SBC #$00
917D 85 09             STA SDES+1
917F 60                RTS


9180           ;
9180           ; ** SEARCH NEXT STRING **
9180           ;
9180 18        NOSTR   CLC
9181 A5 07             LDA STAT
9183 AA                TAX
9184 65 08             ADC SDES          ;ADVANCE DESCRIPTOR POINTER
9186 85 08             STA SDES          ;WITH 7 OR 3
9188 90 02             BCC NOIN
918A E6 09             INC SDES+1
918C E0 07     NOIN    CPX #$07          ;ARE WE DEALING WITH ARRAYS?
918E F0 36             BEQ DOVAR         ;BRANCH IF NOT
9190 A6 09     DOAR    LDX SDES+1
9192 A0 00             LDY #$00
9194 E4 A0             CPX ARP+1         ;END ARRAY REACHED?
9196 D0 19             BNE VAR2          ;BRANCH IF NOT
9198 C5 9F             CMP ARP
919A D0 15             BNE VAR2          ;BRANCH IF NOT
919C F0 3E             BEQ NEXTAR        ;YES, DO NEXT ARRAY
919E A0 00     VARSP   LDY #$00
91A0 B1 08             LDA (SDES),Y
91A2 30 DC             BMI NOSTR         ;BRANCH IF NOT A STRING
91A4 C8                INY
91A5 B1 08             LDA (SDES),Y
91A7 10 D7             BPL NOSTR         ;IDEM
91A9 88                DEY
91AA A5 08             LDA SDES
91AC 69 02             ADC #$02          ;ADD 2 BYTES TO
91AE 90 01             BCC VAR2          ;COMPENSATE FOR NAME
91B0 E8                INX
91B1 85 FC     VAR2    STA SDES1         ;SAVE POINTER TO DESCRIPTOR
91B3 86 FD             STX SDES1+1
91B5 B1 FC             LDA (SDES1),Y
91B7 85 06             STA LEN           ;SAVE LENGTH STRING
91B9 C8                INY

91BA B1 FC             LDA (SDES1),Y
91BC 85 9D             STA SPTR          ;SET POINTER TO STRING
91BE AA                TAX
91BF C8                INY
91C0 B1 FC             LDA (SDES1),Y
91C2 85 9E             STA SPTR+1
91C4 18                CLC               ;RETURN WITH CARRY CLEAR
91C5 60        RTSS    RTS
91C6 A6 09     DOVAR   LDX SDES+1        ;START ARRAY SPACE REACHED?
91C8 E4 6C             CPX ARS+1
91CA D0 D2             BNE VARSP         ;BRANCH IF NOT
91CC C5 6B             CMP ARS
91CE D0 CE             BNE VARSP
91D0 46 07             LSR STAT         ;PROCESS ARRAYS NOW, PUT STAT= 3

91D2 85 9F             STA ARP           ;SAVE POINTER TO ARRAY IN ARP
91D4 86 A0             STX ARP+1
91D6 A5 9F     NEN     LDA ARP
91D8 A6 A0             LDX ARP+1
91DA A0 00             LDY #$00
91DC E4 6E     NEXTAR  CPX EARS+1        ;END ARRAY SPACE REACHED?
91DE D0 04             BNE ARRY          ;BRANCH IF NOT
91E0 C5 6D             CMP EARS
91E2 F0 E1             BEQ RTSS          ;RTS WITH CARRY SET IF SO
91E4 85 08     ARRY    STA SDES
91E6 86 09             STX SDES+1
```

(Continued)

Figure 3 *(Continued)*

```
91E8 B1 08              LDA (SDES),Y      ;GET 1ST CHAR OF ARRAY NAME
91EA AA                 TAX               ;SAVE IN X
91EB C8                 INY
91EC B1 08              LDA (SDES),Y      ;GET 2ND CHAR OF ARRAY NAME
91EE 48                 PHA               ;SAVE ON STACK
91EF C8                 INY
91F0 B1 08              LDA (SDES),Y      ;ADD LENGTH ARRAY TO ARP
91F2 65 9F              ADC ARP
91F4 85 9F              STA ARP
91F6 C8                 INY
91F7 B1 08              LDA (SDES),Y
91F9 65 A0              ADC ARP+1         ;ARP POINTS TO
91FB 85 A0              STA ARP+1         ;NEXT ARRAY
91FD 68                 PLA               ;GET 2ND CHAR OF NAME
91FE 10 D6              BPL NEN           ;BRANCH IF NOT A STRING ARRAY
9200 8A                 TXA               ;GET 1ST CHAR OF NAME
9201 30 D3              BMI NEN           ;BRANCH IF NOT A STRING ARRAY
9203 C8                 INY
9204 B1 08              LDA (SDES),Y      ;GET # OF DIMS
9206 0A                 ASL               ;MULTIPLY BY 2
9207 69 05              ADC #$05          ;ADDOVERHEAD
9209 65 08              ADC SDES          ;ADD SDES
920B 85 08              STA SDES          ;SDES POINTS TO FIRST DESC.
920D 90 81              BCC DOAR          ;OF ARRAY
920F E6 09              INC SDES+1
9211 4C 90 91           JMP DOAR


9214            ;
9214            ;** DEREMENT TOP AND SAVE CHARACTER **
9214            ;
9214 A4 FE      INS     LDY TOP           ;HIGH BYTE DECR. NECESSARY?
9216 D0 02              BNE OK            ;BRANCH IF NOT
9218 C6 FF              DEC TOP+1
921A C6 FE      OK      DEC TOP
921C A0 00              LDY #$00
921E 91 FE              STA (TOP),Y       ;SAVE CHARACTER
9220 60                 RTS



9221            ;
9221            ; ** CHECK/SEARCH NEGATIVE ASCII'S IN STRING POOL
9221            ;
9221 A2 01      CHECK   LDX #$01
9223 B5 73      CHNM    LDA HIM,X         ;COPY HIMEM IN TOP AND IN SPTR

9225 95 FE              STA TOP,X
9227 95 9D              STA SPTR,X
9229 CA                 DEX
922A F0 F7              BEQ CHNM
922C A0 00              LDY #$00
922E A5 9E      DEYY    LDA SPTR+1
9230 C5 70              CMP SPOOL+1       ;IS SPTR(HIGH)<SPOOL(HIGH)?
9232 90 2B              BCC RTS2          ;RETURN WITH CARRY CLEAR IF SO

9234 C6 9E              DEC SPTR+1        ;SET SPTR FOR SEARCH
9236 88         DEYY1   DEY
9237 B1 9D              LDA (SPTR),Y
9239 30 05              BMI FOUND         ;FOUND ONE
923B 98                 TYA
923C D0 F8              BNE DEYY1
923E F0 EE              BEQ DEYY          ;ALWAYS
9240 48         FOUND   PHA               ;SAVE BYTE FOR A WHILE
9241 A6 9E              LDX SPTR+1
9243 98                 TYA
9244 18                 CLC
9245 65 9D              ADC SPTR          ;SPTR=SPTR+Y
9247 90 01              BCC NOINCR
9249 E8                 INX
924A E4 70      NOINCR  CPX SPOOL+1       ;IS SPTR<SPOOL?
924C 90 10              BCC RTS1          ;RETURN WITH CARRY CLEAR IF SO

924E D0 04              BNE SBC2
9250 C5 6F              CMP SPOOL
9252 90 0A              BCC RTS1          ;IDEM
9254 E9 02      SBC2    SBC #$02          ;SPTR=SPTR-2
9256 85 9D              STA SPTR
9258 B0 01              BCS NODECR
925A CA                 DEX
925B 86 9E      NODECR  STX SPTR+1
925D 38                 SEC               ;RETURN WITH CARRY SET
925E 68         RTS1    PLA               ;RESTORE BYTE
925F 60         RTS2    RTS
9260            ;
9260            ; ** END OF PROGRAM **
9260            ;
9260                    END
```

been dimensioned earlier in the program, else an OUT OF DATA error will be generated.

& CLEAR can be used to reduce garbage collection time still further by timely clearing of string arrays. In addition, it can be used to clear numerical working arrays. This will especially be of use if a program consists of several subroutines, each of which require differently dimensioned array space to do data manipulations. By DIMing the working arrays on entry of the subroutine and by clearing them on exit, one prevents that memory from becoming littered with unused arrays. This reduces array access time and leads to fewer 'OUT OF MEMORY' problems.

Finally, & CLEAR can be used to initialize an array to zero, for instance by & CLEAR A: DIM A(20,20). These statements execute about 80 times faster than the usual zero-assignment within a double loop.

Installing the Program

The program has been developed with the excellent BIG MAC assembler, recently released by *Call —A.P.P.L.E.* (for more information see: *Call —A.P.P.L.E.*, Vol. IV, Number 7, page 37). *Editor's note: Figure 3 was reassembled by LISA for purposes of uniformity.*

The machine-language program starts at $9000 and has a length of $260 bytes. After assembling the text file and storing it to disk, the program can be installed by : BRUN programname. This command executes an initialization routine that sets HIMEM to $9000 and installs the & vector. If you want to BRUN the routine from within an Applesoft program, the BRUN command should be inserted at the first line of the program, and must be followed by a CLEAR command. For example:

```
10 PRINT  "BRUN program name":
   CLEAR: REM control D behind first
   quotes.
```

The program makes use of some Applesoft routines in ROM. If the RAM version of Applesoft is being used, the relevant subroutine calls have to be adjusted.

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OSI Extended I/O Processor

by Michael J. Keryan

More than thirty new functions can be added to an OSI C1P by redefining the input, output, and control-C routines. Most of the new functions are activated by either control character keyboard input, or escape sequences placed in BASIC.

Extended I/O
requires:
OSI C1P with 8K
May be modified for other OSI machines.

"Cursor Control for the C1P," by Kerry Lourash (May, 1981 MICRO), added nine utility functions to the input and output routines. I have pieced together the desirable features of most of these smaller programs, and added a number of new ones, such as automatic line number generation. In all, over thirty routines are now available for use during keyboard input, screen output, etc. User-supplied software/hardware additions for a printer, bell, and bug-free garbage collection are also supported. An improved monitor program is included, which can be called at any time. All the constants — screen parameters, subroutine vectors, and flags — were put into tables, rather than imbedded into machine code, making changes relatively easy. The program was originally written for a C2-8P, but the version described here is for a C1P with 8K of memory. The 2K program is ROMable, assuming all the references to the high byte of subroutines ($18 through $1F) are translated to higher memory.

The Video Screen

Several screen parameters are stored in page zero memory, as shown in figure 1 and table 1. There are no restrictions on screen size or video memory location; 32, 64, or non-standard line widths can be supported, as well as video memory at locations other than $Dxxx. Figure 1 shows the window starting near the top of the screen and the flags and monitor fields (described later) near the bottom, but all locations can be modified. During initialization, the parameters are copied from tables within the program (default locations) to lower memory. The parameters can be changed by POKEing into pages zero and two, but the default values will be re-established on each warm start. Therefore, if the default values do not suit you, change them in the upper memory tables.

Cursor Movement

The cursor position is stored in locations $00E0 (low byte) and $00E1 (high byte). The cursor movement functions print the character under the cursor, move the cursor, and print the cursor symbol (stored in location $00E9) at the new position. No other output to the CRT or printer is affected. The following control characters will cause non-destructive cursor movement to any screen location:

Up one line	—	control-U ($15)
Down one line	—	control-D ($04)
Left one space	—	control-L ($0C)
Right one space	—	control-R ($12)
Right eight spaces	—	control-I ($09)

Use of these cursor movements can put the cursor outside an active window. The following movement controls keep the cursor within an active window:

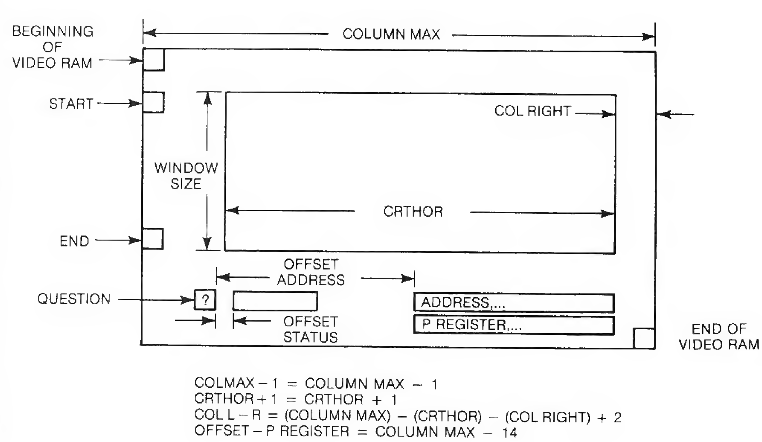
Return to the left of a line
control-Q ($11)

Home cursor (to bottom of window)
control-B ($02)

Backspace (like control L, but stays in margins)
control-H ($08)

Move cursor (to a preset location)
control-N ($0E)

Figure 1: **CRT Screen Parameters**



Control-N will move the cursor to the location stored in $02DA (low byte) and $02DB (high byte). It is now set for the top left corner of the screen. Note that if the preset location is outside the window, control-N will cause the cursor to leave the window.

Window Controls

Active window boundaries are stored in START: $00E2, $00E3, and END: $00E4, $00E5. All CRT output, scrolling, etc., will be maintained within these boundaries. An alternate window is stored in START2: $02D6, $02D7, and END2: $02D8, $02D9. The two windows could be equivalent, partially overlapping, or completely separate.

The two windows can be switched by pressing control-W ($17). In addition to toggling the windows, the cursor will be homed in the new active window.

The window boundaries can be changed by POKEing into the appropriate locations, but are easily changed by using the control-X ($18) key. To use control-X, first place the cursor anywhere on the desired line by using control-U or control-D, then press control-X. You will be prompted for another key with a question mark (at location $00E6, $00E7) and a beep (if this function is implemented), until either a T (for top of window) or a B (for bottom) is pressed. Control-X will only change boundaries of the active window; to change the other window's boundaries, first use control-W.

If the cursor is placed above the window, it will naturally move down into (and be trapped in) the window. If the cursor is placed below the bottom boundary, however, it will not move by itself from that line. This can be used for a one-line non-scrolling window, but a two-line window is the minimum required to give readable text.

Scroll Controls

If the cursor is placed near the top of the window, it will move down the screen as lines of text are output. No scrolling will occur until the cursor attempts to move down when at the bottom of the window; the whole window will then scroll upward and the home line will be blanked. An upward scroll can be forced at any time by pressing control-Y ($19); similarly, a downward scroll is forced by control-Z ($1A). These functions control only the location of the text, which is moved up or down on the screen; they do not move the cursor, which remains stationary. The scrolling functions are useful in editing and in game programs.

Clear Controls

To erase the entire screen, press either control-T ($14) or ESCAPE ($1B). To erase only the active window, press RUBOUT ($7F); this will also home the cursor in the window.

Edit Text

Text can be entered by typing it in as usual, or by placing the cursor anywhere on the screen and pressing control-E ($05). This causes whatever is under the cursor to be entered into BASIC; it has the same effect as typing the character. The cursor is then indexed one space to the right.

When entering a line of text, characters can be deleted with shift O ($5F); this moves the cursor one space backwards, deletes the character from BASIC, and erases it from the CRT. The function of shift P ($64) is not changed; it scratches from BASIC the line being worked on, but does not erase the line from the CRT.

To summarize, text is entered by typing characters (or spaces) or by using control-E over text. Text can be deleted by typing spaces over text when using control-E or with shift O. Text is not changed by using cursor controls; these are used only to position the cursor to allow use of a combination of control-E, character input, or space input.

Autoline

To facilitate easy entry of text, an automatic line entering system can be invoked by inputting control-A ($01). Control-A toggles the autoline mode off or on at any time. It can also be changed by POKEing the status flag. When the autoline mode is on, an A will appear near the bottom of the screen. You then enter a carriage return to activate autoline.

When the system is initialized, the starting line number will be 100 and the increment is 10, resulting in lines numbered 100, 110, 120, ..., 9990. The line number and increment can be changed at any time by POKEing locations $02D0 and $02D1 (line number) and $02D2 (increment). These are packed BCD numbers, four bits per digit. The default values will be re-established on warm start.

When the autoline mode is on, the input routine looks at both the character being entered and the last character. If the last character was a carriage return, you are now at the beginning of a new line, possibly in

***Table 1:* Parameter Location and Values (for C1P)**

PARAMETER	LOCATION	DEFAULT LOCATION	DEFAULT VALUE
CURSOR-LO	$00E0	$1C00	A0
CURSOR-HI	$00E1	$1C01	D0
START1-LO	$00E2	$1C02	A0
START1-HI	$00E3	$1C03	D0
END1-LO	$00E4	$1C04	C0
END1-HI	$00E5	$1C05	D2
QUESTION-LO	$00E6	$1C06	C5
QUESTION-HI	$00E7	$1C07	D3
OK SYMBOL	$00E8	$1C08	E5
CURSOR SYMBOL	$00E9	$1C09	A4
COLUMN MAX	$00EA	$1C0A	20
COLMAX-1	$00EB	$1C0B	1F
COL L-R	$00EC	$1C0C	07
COL RIGHT	$00ED	$1C0D	01
CRTHOR+1	$00EE	$1C0E	1A
STATUS FLAGS	$00EF	$1C0F	82
CONTROL C FLAG	$0212	$1C36	00
AUTOLINE-LO	$02D0	$1C10	90
AUTOLINE-HI	$02D1	$1C11	00
AUTOLINE INCREMENT	$02D2	$1C12	10
LINES/PAGE-CRT	$02D3	$1C13	12
LINES/PAGE-PRINTER	$02D4	$1C14	30
START2-LO	$02D6	$1C16	01
START2-HI	$02D7	$1C17	D3
END2-LO	$02D8	$1C18	80
END2-HI	$02D9	$1C19	D3
MOVE CURSOR-LO	$02DA	$1C1A	A5
MOVE CURSOR-HI	$02DB	$1C1B	D0
OFFSET-STATUS	$02DC	$1C1C	00
OFFSET-ADDRESS	$02DD	$1C1D	08
OFFSET-P REGISTER	$02DE	$1C1E	12

need of a new line number. Entering any character other than a space, a control character, a number from 0-9, a shift-O, or a rubout, will automatically generate a new line number before the key is entered. These exceptions allow certain things to be done without getting a line number put on it: immediate mode commands are invoked by first typing a space, then the command; new line numbers can be inserted between or over existing lines; and all cursor and editing commands can be used. The autoline mode can simply be toggled off by using control-A.

Flag Changes

To change a status flag, use control-F ($06). You will then get a prompt. You must then enter the flag number (from 1 to 8), followed by either a 0 (for off) or 1 (for on). The flag code numbers are:

Flag Number	Code	Description
1	H	Hard copy (printer) mode
2	C	CRT output mode
3	I	Intermittent output (paging) mode
4	T	Trace mode
5	S	Step mode
6	A	Autoline mode
7	M	Monitor save mode
8	E	Extended I/O mode (all functions)

After the flag number and status is entered, the status of all flags will be displayed near the bottom of the screen (these can be erased by escape or control-T). The status can also be changed at any time (e.g., during execution of a BASIC program) by POKEing bits into location $00EF; the flag number corresponds to the bit number. Note that if the E flag is cleared, you can get back into the extended I/O mode by POKEing a number greater or equal to 128 ($80) into $00EF, or a warm start.

CRT and Hardcopy Flags

When these flags are set to 1, a corresponding output to the screen or printer will be created. These flags are independent. To get printed output, a user-supplied printer subroutine must be included: change the NOP's at $1EF7 to JSR $YYXX (20 XX YY), where $YYXX is the address of your subroutine. Prior to this subroutine call, 16 page-zero locations ($00EX) are freed for additional use by the print routine, and are restored before returning to the CRT output.

Print Window

At any time, a control-P ($10) from the keyboard will cause the entire active window to be output to the printer, character by character. The H flag need not be set. The CRT display is not affected.

Intermittent Output

If the I flag is set, the number of lines output to the CRT/printer are counted and stored in locations $02F6/$02D5. These are compared to constants stored in locations $02D3/$02D4. If the line count is equal to the preset page size, the computer will prompt you and wait for a keyboard entry before continuing. This will allow you to copy (or read) CRT text before it scrolls off, or change to a new sheet of paper on the printer. These counts are independent; both are reset to zero on warm start.

Stop/Restart Output

In addition to the above intermittent output mode, a program or listing can be stopped at any time by pressing control-S ($13) and then restarted by control-R ($12). These commands are functional only during output. In many cases, the control S/R sequence is preferred over control C/CONT since no extraneous output is printed.

Step and Trace Modes

If the Step mode is invoked by setting the S flag, only one line of BASIC code will be executed during RUN. You will then be prompted for a keyboard entry, after which the next line will be executed, and so on.

If the Trace mode is invoked by setting the T flag, the BASIC line number will be printed when that line is executed. The output will then be a mixture of line numbers with the normal program output. The program cannot be LISTed while in T mode.

The Step and Trace modes are independent, but for most purposes, are used together for debugging programs. The control-C flag (at location $0212) must be cleared (enabled) to activate either Step or Trace: this is done on warm start.

View Tape

Pressing control-V ($16) will cause entry into the cassette view mode, where BASIC tapes can be read and displayed on the CRT, but are not entered. To exit this mode, enter a space. This routine uses the old I/O vectors to eliminate accidental control character routine activation during viewing.

Bell

An audible prompt is used in several of the above routines. This bell function is also used when a control-G ($07) is either input or output. $07 is output if you attempt to enter more than 71 characters on a line. As an additional feature, the bell is also sounded once after the 64th character, just like a typewriter to warn you that the end of the line is near. To use the Bell feature, the user must supply a subroutine at location $1CEC and the appropriate hardware modifications. (See MICRO, July 1981, "A Typewriter Bell for Your Microcomputer.")

Carriage Return on BASIC Input

With OSI computers, if you respond to an input statement with only a carriage return, you will be kicked out of your program into the immediate mode. You can usually jump back in with a CONT statement, but this is frustrating. On most large computers, such a response is legal. This feature has been added to the input routine. A carriage return will be accepted as a zero for numeric inputs, such as INPUT A, or as a space ($20) for string inputs, such as INPUT A$.

Other Jumps

An input of $1D will cause a jump to the menu ($FF00). This duplicates the function of the Break (Reset) key, and makes it easy to jump there from inside a BASIC program. Inputs of $1C, $1E, or $1F are not used. You can add your own functions by adding your vectors to the tables located at $1800-$183F.

Escape Sequence on Output

Most of the functions are accessed by entering a control character ($01-$1F) from the keyboard, either in immediate mode, or in response to an INPUT statement. These functions can also be accessed on output, either in immediate mode, or by a BASIC program. An escape sequence is used. The escape code ($1B, decimal 27) is output, followed by the control code. For example, to toggle windows, execute:

```
PRINT CHR$(27);CHR$(23);
```

The last semicolon is used to keep the display from scrolling. To output the graphic character for $1B, output two consecutive escapes:

```
PRINT CHR$(27);CHR$(27);
```

Of course, not all functions are suitable for use during a BASIC run, but many are extremely useful, including cursor movements, scrolling, window toggles, screen clear, bell, print, etc. A summary of control functions is shown in table 2.

New Monitor

An improved machine-language monitor routine is accessed by input of control-K ($0B). This monitor is significantly better than OSI's minimal monitor, but not as versatile as commercial monitors. The advantage of this monitor is that it can be called at any time: in immediate mode, in the middle of a BASIC program, or by a JSR machine-language call.

Once the monitor is entered, data appears at the bottom of the screen, as shown in figure 1. The screen locations of this data are set by constants stored at $00E6 (low byte) and $00E7 (high byte), and offsets $02DD and $02DE. There are eight fields shown:

L — Location (four character address)
H — Hexadecimal data stored in L
C — ASCII character stored in L
S — Stack pointer
P — Processor status register (flags)
A — Accumulator
X — X register
Y — Y register

The "cursor" in the monitor mode is controlled by the keys "," and "."; these keys were chosen because the

***Table 2:* Summary of Control Key Functions**

CONTROL KEY	HEX	DECIMAL	FUNCTION	LOCATION
-	00	0	NONE-NULL	$185C
A	01	1	AUTOLINE TOGGLE	$1DF5
B	02	2	BOTTOM CURSOR (HOME)	$19F7
C	03	3	NONE-CONT C	$185C
D	04	4	DOWN CURSOR	$193D
E	05	5	EDIT	$187E
F	06	6	FLAG CHANGE	$1DD0
G	07	7	BELL	$1CEC
H	08	8	BACKSPACE CURSOR	$1905
I	09	9	INCREMENT CURSOR 8 SPACES	$1924
J	0A	10	NONE-LINE FEED	$185C
K	0B	11	MONITOR	$1A48
L	0C	12	LEFT CURSOR	$18F2
M	0D	13	NONE-CARR. RETURN	$185C
N	0E	14	MOVE CURSOR	$1946
O	0F	15	NONE-CONT O	$185C
P	10	16	PRINT WINDOW	$1EA3
Q	11	17	RETURN CURSOR	$1919
R	12	18	RIGHT CURSOR / RESTART	$190E
S	13	19	STOP OUTPUT	$185C
T	14	20	CLEAR SCREEN	$1CA0
U	15	21	UP CURSOR	$192D
V	16	22	VIEW TAPE	$1885
W	17	23	WINDOW TOGGLE	$18A8
X	18	24	SET WINDOW	$18BC
Y	19	25	SCROLL UP	$1894
Z	1A	26	SCROLL DOWN	$189E
ESC	1B	27	CLEAR SCREEN	$1CA0
-	1C	28	--	$185C
-	1D	29	JMP TO $FF00 (MENU)	$1C7A
-	1E	30	--	$185C
-	1F	31	--	$185C

symbols for the left arrow and right arrow appear on these keys. The "," will move the cursor left, the "." will move it right. The cursor actually changes the lower case letters l, h, c, etc., to the upper case letter to be changed. Any field is changed by typing new data into it. The C field will allow any character (except "," and ".") to be entered; the other seven fields allow only hexadecimal (0-9, A-F) characters.

Machine-language programs can thus be entered, or memory reviewed or changed one byte at a time. The space bar is used to step forward through memory; the carriage return key is used to step backwards. To return to where you were before you entered the monitor, type R.

To jump to a subroutine (whose location is shown in L), type J; if the subroutine executes correctly and is terminated by an RTS ($60), control will return to the monitor. All flags and registers (S, P, A, X, and Y) will be changed to what was shown on the screen just before the jump occurred. When returning to the monitor, the contents of S, P, A, X, and Y shown on the screen will reflect their status at the time of return. No provisions are made for single step, trace, trap, etc.

When the monitor mode is entered, several things happen. All flags and registers are saved, and the P field is initialized to $04 (ignore interrupts and clear decimal mode). The S field is adjusted to prevent change to the stack. If the P register is changed, it will automatically be restored on return. However, if the stack is disturbed, you may run into problems when returning, unless the original page one ($01XX) was saved. If the M flag of $00EF is set, the first three pages of memory — page zero (BASIC constants and routines), page one (the stack), and page two (BASIC and Extended I/O constants) — are saved in the top three quarters of screen memory ($D000-$D2FF). This will allow you to use these lower memory locations for your machine-language programs. They will be restored from the screen memory when exiting the monitor mode (R). If the M flag is clear, these three pages will not be saved. Leave the M flag cleared if you merely want to examine or change a few memory locations, or if you don't want the screen display disturbed.

Garbage Collector

A bug in OSI's BASIC-in-ROM may cause your program to bomb if you make extensive use of dimensioned strings. Provisions have been made to allow you to add a foolproof machine-language garbage collection routine. This routine will be called through the revised control-C routine if fewer than 512 bytes of free memory are available; this will keep OSI's defective routine from being called. To use this function, insert $20 XX YY at $1D72, where $YYXX is the location of your new garbage collection routine. In addition, the approximate number of free pages can be monitored at any time by PEEKing at $02F8. This can be used in lieu of FRE(X); never call FRE(X) when using dimensioned strings, as this will force a fatal garbage collection by the defective routine.

Initialization

First cold start, then Break-M, load the tape containing the Extended I/O routines, Break-M, then type .1D1FG. The initialization routine will then be run. The input, output, and control-C vectors are pointed to new routines. The warm start and OK routines are replaced by new ones. Tables are copied from within the program to page zero and page two, where they are used by the new routines. The memory size is adjusted to keep BASIC from overwriting the new routines. The stack is adjusted to prevent an OM error after a warm start, then a message is written to the screen.

***Table 3:* Hex Dump of Complete Program**

```
$1800

5C F5 57 5C 3D 7E D0 EC 05 24 5C 48 F2 5C 46 5C
A3 19 0E 5C A0 2D 85 A8 BC 94 9E A0 5C 7A 5C 5C
18 1D 19 18 19 18 1D 1C 19 19 18 1A 18 18 19 18
1E 19 19 18 1C 19 18 18 18 18 18 1C 18 1C 18 18
A9 AD 8D 07 02 A9 8D 8D 0A 02 A9 60 8D 0D 02 A5
E3 8D 09 02 8D 0C 02 A5 E2 8D 0B 02 60 A9 20 48
20 40 18 A4 E4 A6 E5 68 20 0A 02 EE 0B 02 D0 03
EE 0C 02 CC 0B 02 D0 F0 EC 0C 02 D0 EB 60 AD 01
02 8D 02 02 60 20 F4 FF 20 83 1C 20 7D 1C AD 03
02 D0 F5 60 20 94 19 20 A0 19 20 89 19 60 20 94
19 20 52 1E 20 89 19 60 A2 03 B5 E2 48 BD D6 02
95 E2 68 9D D6 02 CA 10 F1 4C 57 19 20 6C 19 48
A5 E1 48 20 D9 1C C9 54 D0 09 68 85 E3 68 85 E2
18 90 0A C9 42 D0 EC 68 85 E5 68 85 E4 60 20 5D
18 20 CF 19 A5 E5 85 E1 A5 E4 20 6E 19 85 E0 18
90 61 20 94 19 A5 EC 48 A9 00 85 EC 20 7B 19 68
85 EC 18 90 4E 20 94 19 20 74 19 18 90 45 20 94
19 E6 E0 D0 3E E6 E1 D0 3A 20 94 19 20 6C 19 85
E0 18 90 2F A2 08 20 0E 19 CA D0 FA 60 20 94 19
A5 E0 38 E5 EA 85 E0 B0 1A C6 E1 D0 16 20 94 19
20 5D 19 18 90 0D 20 94 19 AD DA 02 85 E0 AD DB
02 85 E1 20 89 19 60 20 94 19 4C E4 18 A5 E0 18
65 EA 85 E0 90 02 E6 E1 EA EA EA 60 A5 E0 05 EB
38 E5 EE 60 20 6C 19 C5 E0 D0 0B A5 E0 38 E5 EC
85 E0 B0 02 C6 E1 C6 E0 60 A0 00 B1 E0 8D 01 02
A5 E9 D0 03 AD 01 02 A0 00 91 E0 60 A5 E8 D0 F7
20 40 18 18 65 EA 90 03 EE 09 02 8D 08 02 A6 E4
A4 E5 20 07 02 EE 08 02 D0 03 EE 09 02 EE 0B 02
D0 03 EE 0C 02 EC 0B 02 D0 E8 CC 0C 02 D0 E3 A4
EB A9 20 91 E4 88 10 FB 60 AD 02 02 C9 20 B0 F8
AA BD 00 18 8D F1 02 BD 20 18 8D F2 02 6C F1 02
EE D5 02 EA EA EA 18 90 1B A9 20 20 97 19 20 2D
```

Table 3 *(continued)*

```
$1A00

1A 18 90 10 C6 0E A9 20 8D 01 02 20 97 19 20 74
19 20 90 19 4C F6 1F EA EA EA 8D 01 02 20 97 19
E6 E0 A5 E0 05 EB 38 E5 ED C5 E0 D0 17 EE F6 02
20 6C 19 85 E0 C5 E4 A5 E1 E5 E5 B0 04 4C 40 19
EA 20 A0 19 20 89 19 60 08 48 8A 48 98 48 BA CA
CA 86 43 24 EF 50 1C A2 00 B5 00 9D 00 D0 CA D0
F8 BD 00 01 9D 00 D1 CA D0 E7 BD 00 02 9D 00 D2
CA D0 F7 A5 E6 18 6D DD 02 85 49 A2 00 8A 20 98
1A A2 04 86 44 6D DE 02 20 98 1A A5 E7 85 4A 20
A8 1A 20 22 1B 18 90 F7 95 4B 69 06 95 4C 69 04
95 4D 69 04 95 4E 60 EA A2 07 B4 4B BD 1A 1B 91
49 CA 10 F6 A6 42 B4 4B BD 1A 1B 29 DF 91 49 A2
07 B5 40 20 FE 1A B4 4B 20 0F 1B CA E0 02 D0 F1
A0 00 B1 40 A4 4D C8 91 49 20 FE 1A A4 4C 20 0F
1B A5 41 20 FE 1A A4 4B 20 0F 1B A5 40 20 FE 1A
20 0F 1B 60 29 0F F8 18 69 90 69 40 D8 60 48 4A
4A 4A 4A 20 F4 1A 85 53 68 20 F4 1A 85 54 60 C8
A5 53 91 49 C8 A5 54 91 49 60 6C 68 63 73 70 61
78 79 20 83 1C C9 2C D0 09 C6 42 10 04 A9 07 85
42 60 C9 2E D0 0D E6 42 A6 42 E0 08 90 04 A9 00
85 42 60 A6 42 E0 02 D0 05 A2 00 81 40 60 C9 0D
D0 09 A5 40 D0 02 C6 41 C6 40 60 C9 20 D0 07 E6
40 D0 02 E6 41 60 C9 4A D0 27 BA 86 48 A6 43 9A
A6 46 A4 47 A5 44 48 A5 45 28 20 8E 1B 08 85 45
68 85 44 84 47 86 46 BA 86 43 A6 48 9A 60 6C 40
00 C9 52 D0 2E 68 68 AD 00 D0 C9 4C D0 1E EA EA
A2 00 BD 00 D0 95 00 CA D0 F8 BD 00 D1 9D 00 01
CA D0 F7 BD 00 D2 9D 00 02 CA D0 F7 68 A8 68 AA
68 28 60 48 20 93 FE 10 02 68 60 A8 68 98 A6 42
D0 0E A2 03 06 40 26 41 CA 10 F9 05 40 85 40 60
E0 01 D0 0F 85 48 A2 00 A1 40 0A 0A 0A 0A 05 48
81 40 60 16 40 16 40 16 40 16 40 15 40 95 40 60
```

Listing 1: BASIC Program to Print a Hex Dump

```
100 POKE239,131
105 PRINT:PRINT"$1800"
110 FORI=6144TO6655STEP16
120 PRINT
130 FORJ=0TO15
140 K=I+J
150 A=PEEK(K):POKE85,A
160 POKE11,247:POKE12,28
170 X=USR(0):C=PEEK(83):D=PEEK(84)
180 PRINTCHR$(C);CHR$(D);" ";
190 NEXTJ,I
200 POKE239,130
```

Odds and Ends

A subroutine that will decode a byte into two ASCII characters is located at $1CF7. Place the byte to be decoded into $0055. A JSR $1CF7 will leave the high nibble character in $0053, the low one in $0054. An example of this routine is shown in listing 1. The simple program generated the hexadecimal dumps of table 3. Lines 100 and 200 turned the printer on and off. Line 160 set the USR vector to $1CF7.

A dump of the entire 2K program is shown in table 3; the underlined bytes are those that will require changing if the program is relocated. Here are the locations that will require changing if your OSI computer is not a C1P:

Location	Function	C1P Location (low, high)
$1C7E	Old Output Routine	6 9 F F
$1C81	Old Output + 3	6C FF
$1C84	Old Input	BA FF
$1D5D	Old Control-C Routine	9B FF

However, you *must* have a support ROM (or EPROM) containing indirect vectors for these routines, which vector through page two of memory.

Due to its length, the assembly listing could not be reproduced here. For a copy of the 40-page listing, send $5 to the author. (Sorry, I cannot provide copies on tape.)

The control keys can be redefined any way you see fit, by changing the pointers shown in table 2; these are stored at the beginning of the program ($1800-$183F). You may want to eliminate some functions (such as printer routines) and add others. You may want to let some keys generate predefined strings that can be entered into BASIC, such as DATA, or FOR I=1TO, etc. For hints on how to do this, study the autoline code. You may want to make some changes. I have yet to use a program that didn't need a few alterations.

Michael Keryan has a Master of Science in Chemical Engineering. His interest is in hardware projects; he built an OSI system a few years ago and added a number of extensions, including two printers, music generators, and a real time clock. Contact Mr. Keryan at 713 Locust Drive, Tallmadge, OH 44278.

MICRO™

Table 3 *(continued)*

```
$1C00

A5 D0 A0 D0 C0 D2 C5 D3 E5 A4 20 1F 07 01 1A 82
90 00 10 12 30 00 01 D3 80 D3 A5 D0 00 08 12 25
A9 A2 A0 1D 20 C3 A8 60 EA 4C 1F 1D 4C 9A 1E FE
1E 5E 1F 42 1D A9 00 8D 12 02 A9 00 8D F6 02 A9
AA 8D F4 02 A2 0F BD 00 1C 95 E0 CA 10 F8 A2 0F
BD 10 1C 9D D0 02 CA 10 F7 A9 18 85 86 A9 00 8D
D5 02 EA EA A2 05 BD 29 1C 95 00 CA 10 F8 A2 05
BD 2F 1C 9D 18 02 CA 10 F7 60 4C 00 FF 4C 69 FF
4C 6C FF 4C BA FF EA EA 48 8A 48 A2 0F BD E0 02
48 B5 E0 9D E0 02 68 95 E0 CA 10 F1 68 AA 68 60
48 98 48 A0 00 A9 20 99 00 D7 99 00 D6 99 00 D5
99 00 D4 99 00 D3 99 00 D2 99 00 D1 99 00 D0 C8
D0 E5 68 A8 68 60 20 D0 1C C9 0A B0 F9 48 68 60
20 D9 1C 20 93 FE 30 F8 60 20 EC 1C A2 00 A9 3F
81 E6 20 83 1C 48 A9 20 81 E6 68 60 48 EA EA EA
EA EA EA EA EA 68 60 A5 55 4C FE 1A 48 20 16 1D
C9 BE D0 10 A9 F7 20 18 1D C9 7F D0 07 20 D9 1C
C9 12 D0 F9 68 60 A9 FE 8D 00 DF AD 00 DF 60 20
A0 1C AD F4 02 C9 AA F0 00 A9 00 8D D5 02 8D F6
02 EA EA EA 20 35 1C EA EA 20 20 1C A2 FE 9A 4C
74 A2 AD 12 02 D0 1E A5 EF 29 10 F0 03 20 D9 1C
A5 EF 29 08 F0 03 20 5A B9 20 66 1D 4C 9B FF EA
EA EA EA EA EA 60 A5 82 38 E5 80 8D F8 02 C9 02
B0 03 EA EA EA 60 A2 08 A9 01 8D F0 02 8A 18 6D
DC 02 A8 AD F0 02 25 EF D0 04 A9 20 D0 03 BD 99
1D 91 E6 0E F0 02 CA D0 E4 60 45 4D 41 53 54 49
43 48 45 78 74 65 6E 64 65 64 20 49 2F 4F 20 50
72 6F 63 65 73 73 6F 72 0D 0A 43 31 50 20 56 65
72 73 69 6F 6E 20 63 2E 4D 4B 20 31 39 38 31 00
20 C6 1C AA A9 01 CA F0 03 0A D0 FA 48 20 C6 1C
D0 0A 68 49 FF 25 EF 85 EF 18 90 05 68 05 EF 85
EF 20 76 1D 60 A9 20 45 EF 85 EF 4C 76 1D AD 02
```

Table 3 *(continued)*

```
$1E00

02 C9 5F F0 44 C9 7F F0 40 C9 21 90 3C C9 3A B0
04 C9 30 B0 34 18 F8 AD D0 02 6D D2 02 8D D0 02
48 AD D1 02 69 00 8D D1 02 48 D8 A2 00 4A 4A 4A
4A 20 4A 1E 68 29 0F 20 4A 1E 68 48 4A 4A 4A 4A
20 4A 1E 68 29 0F 20 4A 1E 60 09 30 95 13 E8 4C
1A 1A 20 40 18 A5 E5 8D 09 02 8D 0C 02 A5 E4 05
EB 8D 0B 02 38 E5 EA B0 03 CE 09 02 8D 08 02 A6
E2 A4 E3 20 07 02 CE 08 02 D0 03 CE 09 02 CE 0B
02 D0 03 CE 0C 02 EC 0B 02 D0 E8 CC 0C 02 D0 E3
A4 EB A9 20 91 E2 88 10 FB 60 A9 0D 20 5E 1F 4C
9C 19 EA 48 8A 48 98 48 A5 E0 48 A5 E1 48 EA EA
EA EA A5 E2 85 E0 A5 E3 85 E1 A0 00 A9 0D 20 F4
1E A6 EA B1 E0 20 F4 1E E6 E0 D0 02 E6 E1 CA D0
F2 A9 0D 20 F4 1E A5 E1 C5 E5 90 E5 A5 E0 C5 E4
90 DF F0 DD EA EA EA EA 68 85 E1 68 85 E0 68 A8
68 AA 68 60 20 88 1C EA EA EA 20 88 1C 60 A5 EF
30 03 4C 83 1C 20 83 1C 8D 02 02 98 48 8A 48 A9
40 C5 0E D0 03 20 EC 1C A9 0D CD F3 02 D0 1B CD
02 02 D0 08 A9 20 20 4C 1E 18 90 09 A5 EF 29 20
F0 08 20 FE 1D 8A A8 68 98 48 AD 02 02 C9 7F D0
03 20 DE 18 20 D9 19 EA EA EA EA EA EA EA EA EA
AD 02 02 8D F3 02 68 AA 68 A8 AD 02 02 60 48 8D
02 02 A5 EF 30 04 68 4C 7D 1C 8A 48 98 48 20 FC
1C A5 EF 29 01 F0 1C A5 EF 29 04 F0 10 AD D5 02
CD D4 02 90 08 20 D9 1C A9 00 8D D5 02 AD 02 02
20 F4 1E A5 EF 29 02 F0 5F A5 EF 29 04 F0 10 AD
F6 02 CD D3 02 90 08 20 D9 1C A9 00 8D F6 02 AD
02 02 C9 0A D0 03 4C F0 19 C9 0D D0 03 4C F9 19
C9 5F D0 03 4C 04 1A C9 07 D0 03 20 EC 1C C9 1B
D0 11 AD F5 02 D0 07 A9 01 8D F5 02 D0 1A A9 00
8D F5 02 AD F5 02 F0 0A 20 D9 19 A9 00 8D F5 02
F0 06 AD 02 02 20 1A 1A 68 A8 68 AA 68 4C 80 1C
```

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Delete on the OSI

by Earl Morris and Yasuo Morishita

This utility will show the ROM BASIC user how to delete blocks of lines, as well as single lines, with just a few keystrokes.

DELETE
requires:
OSI C1P

This article describes a routine to allow users of OSI ROM BASIC to delete multiple lines. Normally only a single line of BASIC can be deleted by typing in the line number followed by a carriage return. This can be tedious if a large block of lines must be removed. This often happens, for example, when programs are merged or a utility program is run with another program also in memory. The "DELETE" program creates a USR routine which is called by

Z = USR (first line)(last line)

All of the lines of BASIC with line numbers inside the specified range are then deleted.

When OSI ROM BASIC is called on to delete a single line, two major routines are used. The code at $A2A2 finds the line to be deleted, and then shrinks the program by the number of bytes found in the offending line. Another routine at $A31C is responsible for refixing the pointers that rechain each line to the next. Unfortunately these routines are not written as subroutines and thus cannot be used by "outside" programs.

However, the DELETE program copies these routines from ROM into RAM and creates the needed subroutine. The main line DELETE pro-

BASIC Program to Set Up USR Delete Function

```
10 REM  BASIC LINE DELETE
12 REM FORMAT :  Z=USR(START LINE #)(END LINE #)
14 M=565:REM START ADDRESS=$0235 RELOCATABLE
16 A=INT(M/256):POKE12,A:POKE11,M-A*256
18 N=64:FORX=MTOM+N-1:READJ:POKEX,J:NEXT
20 A=41634:M=M+N:N=68:GOSUB28:REM DELETE=$A2A2
22 A=INT(M/256):B=M-256*A:POKEM-13,A:POKEM-14,B
24 A=41756:M=M+N:N=47:GOSUB28:REM REBUILD  =$A31C
26 POKEM+15,96:END: REM "RTS"
28 FORX=0TON-1:J=PEEK(A+X):POKEM+X,J:NEXT:RETURN
30 DATA32,8
32 DATA180,32,173,170,32,49,184,165,175,133
34 DATA48,165,174,133,49,32,50,164
36 DATA176,27,160,1,177,170,240,26,160,3
38 DATA177,170,133,18,136,177,170,133,17
40 DATA166,48,165,49,228,17,229,18
42 DATA144,5,32,125,2,240,219,169,146,160
44 DATA161,32,195,168,76,25,163
```

Source Code for Main Delete Program

```
                    ;DELETE
                    ;BY MORRIS & MORISHITA
                    ;
                    ;ASSEMBLY LANGUAGE LISTING
                    ;
                            ORG $235

                    ;
0235 20 08 B4               JSR $B408       ;1ST ARGUMENT TO BINARY INTO $
11,12 (START)
0238 20 AD AA               JSR $AAAD       ;GET 2ND ARGUMENT (LAST LINE # )

023B 20 31 B8               JSR $B831       ;CONVERT TO BINARY
023E A5 AF                  LDA $AF
0240 85 30                  STA $30         ;STORE FINAL LINE # IN $30,31
0242 A5 AE                  LDA $AE
0244 85 31                  STA $31
0246 20 32 A4       LBLA    JSR $A432       ;FIND ADDRESS OF BASIC LINE
0249 B0 1B                  BCS LBLB        ;BRANCH IF FOUND, OTHERWISE UP
                                             DATE POINTER AT $11,12
024B A0 01                  LDY #$01
024D B1 AA                  LDA ($AA),Y     ;LOOK AT POINTER TO NEXT LINE
024F F0 1A                  BEQ LBLC        ;IF NULL MUST BE END OF PROGRAM
                                             SO QUIT
0251 A0 03                  LDY #$03
0253 B1 AA                  LDA ($AA),Y     ;GET NEXT LINE # HI BYTE
0255 85 12                  STA $12
0257 88                     DEY
0258 B1 AA                  LDA ($AA),Y     ;GET NEXT LINE # LO
025A 85 11                  STA $11

025C A6 30                  LDX $30         ;LOAD X,A WITH FINAL LINE
025E A5 31                  LDA $31
0260 E4 11                  CPX $11         ;COMPARE TO CURRENT LINE
0262 E5 12                  SBC $12
0264 90 05                  BCC LBLC        ;QUIT IF BEYOND FINAL LINE
0266 20 75 02       LBLB    JSR $0275
0269 F0 DB                  BEQ LBLA        ;ALWAYS BRANCH
026B A9 92          LBLC    LDA #$92
026D A0 A1                  LDY #$A1        ;$A192 IS ADDRESS OF "OK"
026F 20 C3 A8               JSR $A8C3       ;PRINT "OK"
0272 4C 19 A3               JMP $A319       ;GO BACK TO BASIC
0275                ;
0275                        END
```

gram accepts the first line to be deleted and calls the copied ROM routine to do the work. Then the line pointers are used to find the line number of the next BASIC line. This is checked for end of program, and checked to see if it exceeds the upper limit for deleting. Then the copied routines are called again and the process is repeated until completed. Lines are still deleted one at a time, but the computer, rather than your busy fingers, is doing the work.

The BASIC program listed here will create the DELETE program on page two below the start of BASIC program space. This memory is normally unused in OSI machines. If you are using this space, then the delete program can be relocated by changing the value of "M" in line 14. Line 16 sets up the USR vector, and line 18 builds the main program from the DATA statements. Line 20 moves the "memory close" routine from ROM. Line 22 calculates an absolute JSR address and POKEs it into the main program. Line 24 copies the rechaining routine from ROM and line 26 adds an "RTS" to convert it to a subroutine.

After running the BASIC program, it can delete itself with:

```
Z = USR (10)(44)
```

Note that the USR function now requires two arguments and will give an "SN" error if both are not present. Everything is deleted by Z=USR(1)(−1) which of course is the same as a NEW command. The form Z=USR(A)(B) is also helpful to figure out which lines to omit.

For those readers interested in how the program works, the source code for the main program is listed with comments. The code is relocatable with the exception of the JSR at $026E. This is a jump to the copied ROM routines. The BASIC set-up program automatically fixes this absolute address.

Earl Morris may be contacted at 3200 Washington, Midland, Michigan 48640. Contact Yasuo Morishita at 950 Beau Drive #106, Des Plains, Illinois 60016.

MICRO™

Apple Slices

By Tim Osborne

This month's Apple Slices shows you how to access directly any sector on an unprotected Disk II 16-sector diskette. And I'll discuss further how to pass an Applesoft arithmetic expression from BASIC to machine language (see last month's column (50:59)).

The DOS RWTS Subroutine

This method uses the DOS subroutine RWTS, which stands for Read or Write a Track or Sector. You may find this method referred to as physical I/O because it deals with physical data-access locations. It can be handy in error trapping, fixing clobbered diskettes, customizing catalogs, file and space management, accessing disks from machine language, and transferring files between different operating systems.

To connect to RWTS the user program should JSR to the RWTS vector located at $3D9. Upon entry to RWTS the A + Y registers must contain the address of the IOB (Input/Output control Block). The IOB is a table of parameters that describes to RWTS what operation it is being called to perform. For a breakdown of the IOB, see page 95 of the Apple II DOS Manual. The IOB in turn contains the address of the DCT (Device Characteristics Table) in bytes seven and eight. The DCT provides physical and timing information to the RWTS subroutine.

The Example

I have written a handy subroutine, AMPERRWTS, which allows the user to call RWTS from BASIC using the following syntax:

1 . READ; &R(T,S,B,D)
&R(T,S,B)

2. WRITE; &W(T,S,B,D)
&W(T,S,B)

T = A valid Applesoft arithmetic expression representing a track number (0-34).

S = A valid Applesoft arithmetic expression representing a sector number (0-15).

***Listing 1:* AMPERRWTS**

```
0800              ;********************************
0800              ;*                              *
0800              ;*         APPLE SLICES         *
0800              ;*     ACCESSING RWTS FROM      *
0800              ;*            BASIC             *
0800              ;*                              *
0800              ;*         TIM   OSBORN         *
0800              ;*                              *
0800              ;********************************
0800              ;
0800              ;      APPLESOFT ENTRY POINTS
0800              ;
00B1              CHRGET   EPZ $B1          ;INCREMENT TXTPTR AND GET CHAR
                                             ACTER
00B7              CHRGOT   EPZ $B7          ;CHRGET - INCREMENT
DEBB              CHKOPN   EQU $DEBB        ;CHECK FOR "(" @ TXTPTR
DEBE              CHKCOM   EQU $DEBE        ;CK. FOR "," @ TXTPTR
D995              DATA     EQU $D995        ;ADVANCE TXTPTR TO END OF STAT
                                             EMENT
DD67              FRMNUM   EQU $DD67        ;EVALUATE EXPRESSION @ TXTPTR
                                              + PUT IN FAC
E6FB              CONINT   EQU $E6FB        ;MODIFY FAC TO 8 BIT INTEGER
E752              GETADR   EQU $E752        ;MODIFY FAC TO 16 BIT INTEGER
DEC9              SYNERR   EQU $DEC9        ;PRINT SYNTAX ERROR MESSAGE
03F5              AMPERV   EQU $3F5         ;AMPERSAND VECTOR ADDRESS
0800              ;
0800              ;      MONITOR ENTRY POINT
0800              ;
FDB3              XAM      EQU $FDB3        ;HEX DUMP ROUTINE
0800              ;
0800              ;      DOS ENTRY POINT VECTOR
0800              ;
03D9              RWTS     EQU $03D9        ;READ-WRITE-TRACK-SECTOR
0800              ;
0800              ;      ZERO PAGE EQUATES
0800              ;
003C              A1L      EPZ $3C          ;2-BYTE MONITOR PARAMETER
003E              A2L      EPZ $3E          ;2-BYTE MONITOR PARAMETER
0050              LINNUM   EPZ $50
0073              HIMEM    EPZ $73
0800              ;
0800              ;
0800              ;      OTHER EQUATES
0800              ;
0001              READ     EPZ $01            AD OPERATION CODE
0002              WRITE    EPZ $02          ;WRITE OPERATION CODE
002C              COMMA    EPZ $2C
0052              R        EPZ $52
0057              W        EPZ $57
0058              X        EPZ $58
0800              ;
0800              ;
8000                       ORG $8000
8000                       OBJ $800
8000              ;SETVEC SETS HIMEM AND AMPERSAND VECTOR
8000              ;
8000 A9 0F        SETVEC   LDA #ENTRY
8002 8D F6 03              STA AMPERV+1
8005 85 73                 STA HIMEM
8007 A9 80                 LDA /ENTRY
8009 8D F7 03              STA AMPERV+2
800C 85 74                 STA HIMEM+1
800E 60                    RTS
800F              ;
800F              ;
800F              ;
800F              ;        MAIN PROGRAM
800F              ;
800F C9 52        ENTRY    CMP #R           ;READ REQUEST?
8011 D0 08                 BNE WRITE?
8013 A9 01                 LDA #READ        ;YES LD + SV READ
8015 8D D7 80              STA IBCMD        ;OPERATION CODE IN IOB
8018 4C 59 80              JMP RWTSCALL
801B C9 57        WRITE?   CMP #W           ;WRITE REQUEST?
801D D0 08                 BNE XAM?         ;NO, CONTINUE
801F A9 02                 LDA #WRITE       ;YES, LD + SV WRITE
8021 8D D7 80              STA IBCMD        ;OPERATION CODE IN IOB
8024 4C 59 80              JMP RWTSCALL
8027 C9 58        XAM?     CMP #X           ;MEMORY XAM REQUEST?
8029 F0 03                 BEQ XAMINE       ;YES
802B 4C C9 DE              JMP SYNERR       ;NO, MUST BE ERROR
802E 20 B1 00     XAMINE   JSR CHRGET       ;GET NEXT CHARACTER AND
8031 20 BB DE              JSR CHKOPN       ;CHECK FOR "("
8034 20 67 DD              JSR FRMNUM       ;GET BEGINNING ADDRESS
8037 20 52 E7              JSR GETADR       ;CONVERT TO INTEGER
803A A5 50                 LDA LINNUM
803C 85 3C                 STA A1L          ;AND STORE FOR XAM
803E A5 51                 LDA LINNUM+1
8040 85 3D                 STA A1L+1
```

Listing 1 *(Continued)*

```
8042 20 BE DE             JSR CHKCOM          ;CHECK FOR ","
8045 20 67 DD             JSR FRMNUM          ;GET ENDING ADDRESS
8048 20 52 E7             JSR GETADR          ;CONVERT TO INTEGER
804B A5 50                LDA LINNUM
804D 85 3E                STA A2L             ;AND STORE FOR XAM
804F A5 51                LDA LINNUM+1
8051 85 3F                STA A2L+1
8053 20 B3 FD             JSR XAM
8056 4C 95 D9             JMP DATA            ;ADVANCE TXTPTR + RETURN TO BASIC
8059           ;
8059           ;
8059 20 B1 00  RWTSCALL   JSR CHRGET          ;GET NEXT CHARACTER AND
805C 20 BB DE             JSR CHKOPN
805F 20 67 DD             JSR FRMNUM          ;GET TRACK NUMBER
8062 20 FB E6             JSR CONINT          ;CONVERT TO 1 BYTE INTEGER
8065 E0 23                CPX #$23            ;TRACK LESS THAN 35?
8067 30 03                BMI RWTS1           ;YES, CONTINUE
8069 4C C9 DE             JMP SYNERR          ;NO, DISPLAY MESSAGE
806C 8A        RWTS1      TXA
806D 8D CF 80             STA IBTRK           ;AND STORE IN PARMLIST
8070 20 BE DE             JSR CHKCOM          ;CHECK FOR ","
8073 20 67 DD             JSR FRMNUM          ;GET SECTOR NUMBER
8076 20 FB E6             JSR CONINT
8079 E0 10                CPX #$10            ;SECTOR LESS THAN 16?
807B 30 03                BMI RWTS2           ;YES, CONTINUE
807D 4C C9 DE             JMP SYNERR          ;NO, DISPLAY MESSAGE
8080 8A        RWTS2      TXA
8081 8D D0 80             STA IBSECT          ;AND STORE IN PARMLIST
8084 20 BE DE             JSR CHKCOM          ;CHECK FOR ","
8087 20 67 DD             JSR FRMNUM          ;GET BUFFER ADDRESS
808A 20 52 E7             JSR GETADR          ;CONVERT TO TWO BYTE INTEGER
808D A5 50                LDA LINNUM
808F 8D D3 80             STA IBBUFP          ;AND STORE IN PARMLIST
8092 C8                   INY
8093 A5 51                LDA LINNUM+1
8095 8D D4 80             STA IBBUFP+1
8098 20 B7 00             JSR CHRGOT          ;LOAD ACCUM WITH (TXTPTR)
809B C9 2C                CMP #COMMA          ;IS IT A COMMA
809D D0 13                BNE NODRIVE         ;NO, DRIVE NOT SPECIFIED
809F 20 B1 00             JSR CHRGET          ;YES , ADVANCE TXTPTR
80A2 20 67 DD             JSR FRMNUM          ;GET DRIVE NUMBER
80A5 20 FB E6             JSR CONINT          ;AND CONVERT TO INTEGER
80A8 8A                   TXA                 ;TRANSFER DRIVE # TO ACCUM
80A9 F0 04                BEQ RWTS3           ;SHOULD NOT BE = ZERO
80AB E0 03                CPX #$03            ;DRIVE NO. < 3?
80AD 30 05                BMI YESDRV          ;YES, CONTINUE
80AF 4C C9 DE  RWTS3      JMP SYNERR          ;NO, DISPLAY ERROR MESSAGE
80B2 A9 01     NODRIVE    LDA #$01            ;DEFAULT TO DRIVE #1
80B4 8D CD 80  YESDRV     STA IBDRVN          ;STORE IN PARMLIST
80B7 A9 DC                LDA #DCT            ;GET DCT ADDRESS(LOW)
80B9 8D D1 80             STA IBDCTP          ;AND STORE IN PARMLIST
80BC A9 80                LDA /DCT            ;DCT(HIGH)
80BE 8D D2 80             STA IBDCTP+1
80C1 A9 80                LDA /IOB            ;SET UP DCT ADDRESS PARAMETERS
80C3 A0 CB                LDY #IOB            ;FOR RWTS
80C5 20 D9 03             JSR RWTS
80C8 4C 95 D9             JMP DATA            ;ADVANCE TXTPTR TO END OF STAT
                                               EMENT
80CB           ;                              ;AND RETURN TO BASIC
80CB           ;
80CB           ;INTERNAL STORAGE AREA
80CB           ;
80CB           ;
80CB           ;****************************
80CB           ;*                          *
80CB           ;* INPUT/OUTPUT CONTROL BLK *
80CB           ;*                          *
80CB           ;****************************
80CB           ;
80CB           IOB        EQU *
80CB           IBTYPE     DFS $01,$01         ;TYPE OF IOB
80CC           IBSLOT     DFS $01,$60         ;SLOT NUMBER
80CD           IBDRVN     DFS $01             ;DRIVE NUMBER
80CE           IBVOL      DFS $01,$00         ;VOLUME NO. 0=WILDCARD
80CF           IBTRK      DFS $01             ;TRACK NO.
80D0           IBSECT     DFS $01             ;SECTOR NO.
80D1           IBDCTP     DFS $02             ;POINTER TO DCT
80D3           IBBUFP     DFS $02             ;POINTER TO BUFFER
80D5           IBDUMY     DFS $02,$00         ;UNUSED
80D7           IBCMD      DFS $01             ;0=NULL,1=READ,2=WRITE,4=FORMAT
80D8           IBSTAT     DFS $01,$00         ;ERROR CODE (FOLLOWING CODES APPLY)
80D9           ;                              ;$10=WRITE PROTECT
80D9           ;                              ;$20=VOLUME MISMATCH
80D9           ;                              ;$40=DRIVE ERROR
80D9           ;                              ;$80=READ ERROR
80D9           IBSMOD     DFS $01,$00         ;ACTUAL VOLUME NO.
80DA           IOBPSN     DFS $01,$60         ;PREVIOUS SLOT NO.
80DB           IOBPDN     DFS $01,$01         ;PREVIOUS DRIVE NO.
80DC           ;
80DC           ********************************
80DC           *                              *
80DC           * DEVICE CHARACTERISTICS TABLE *
80DC           *                              *
80DC           ********************************
80DC           ;
80DC           DCT        EQU *
80DC           DEVTPC     DFS $01,$00         ;DEVICE TYPE CODE
80DD           PPTC       DFS $01,$01         ;PHASES PER TRACK
80DE           MONTC1     DFS $01,$EF         ;TIME COUNT
80DF           MONTC2     DFS $01,$D8         ;TIME COUNT
80E0           ;
80E0           ;
80E0                      END
```

B = A valid Applesoft arithmetic expression representing the starting address of a 256-byte buffer.

D = A valid Applesoft arithmetic expression representing a drive number (1-2). The D parameter is optional and the program will default to a value of 1 if it is not coded in the &R or &W statement.

I have included for convenience a routine to call the monitor routine XAM directly from BASIC. This routine can be used to examine a hex dump of the RWTS buffer, or any range of memory in the Apple II. The syntax is as follows:

& X(B,E)

B = A valid Applesoft arithmetic expression representing the beginning of the range of memory to be dumped.

E = A valid Applesoft arithmetic expression representing the ending addresss of the range of memory to be dumped.

When XAM is dumping a range of memory, it may have more than a screen's worth of data, in which case you may wish to use the CTRL-S key to stop-list the dump. Any key will restart the dump. When the dump is completed, control returns back to the user program or the "]" prompt if this command is issued from the immediate mode.

How AMPERRWTS Works

AMPERRWTS uses the following subroutines, which are essential to its performance:

1. CHRGET $B1

Increments TXTPTR, loads the accumulator with the value TXTPTR is pointing at.

2. CHRGOT $B7

Same as CHRGET except CHRGOT does not increment the TXTPTR.

3. CHKOPN $DEBB

Checks at TXTPTR for an open parenthesis "(". Displays a syntax error if not found. Post-increments the TXTPTR through CHRGET.

4. CHKCOM $DEBE

Checks at TXTPTR for a comma. Displays a syntax error if not found. Post-increments the TXTPTR through CHRGET.

5. DATA $D995

Advances the TXTPTR to the end of the current Applesoft statement.

6. FRMNUM $DD67

Evaluates the arithmetic expressions @TXTPTR, and places the result in the FAC (floating point accumulator).

7. CONINT $E6FB

Evaluates the FAC and places the result in the X-register as an 8-bit X integer (0-255).

8. GETADR $E752

Evaluates the FAC and places the result into LINNUM ($50-$51) as a 16-bit integer (0-65535).

9. SYNERR $DEC9

Displays a syntax error message.

To install AMPERRWTS the user must BRUN the binary object file. This sets up the ampersand vector for Applesoft ($3F5). When the "&" is encountered, Applesoft will pass control to ENTRY at $800F. ENTRY first looks for an R, W, or X in the accumulator. If an R is found, a 1 is placed in IBCMD (the IOB command parameter), then a jump to the internal routine RWTSCALL is performed. The parameters are: 0 = null command — position head and start drive; 1 = read specified sector; 2 = write specified sector; 4 = format disk. For more information see page 97 of the DOS manual. If a W is found, a 2 is placed in IOBCMD and a JMP to RWTSCALL is performed. If an X is found, the internal routine XAMINE is JMPed to. If the accumulator is not equal to an R, W, or X, then a syntax error message is displayed.

RWTSCALL is the heart of AMPERRWTS. It evaluates the parameters passed between the left and right parentheses for the &R and &W commands, and sets up the IOB to make a proper call to RWTS. First, RWTSCALL advances the TXTPTR through a JSR to CHRGET. Then RWTSCALL JSRs to CHKOPN because we now expect, as defined in the above syntax diagrams, that we will find a left parenthesis ("("). If "(" is found, the TXTPTR will be advanced to point to what is expected to be an arithmetic expression that will result in a value between 0 and 34 (track number). This expression is evaluated through a JSR to FRMNUM, which places the result in the FAC. A JSR to CONINT converts the FAC to an 8-bit value and places it in the X-register. RWTSCALL then checks the X-register to make sure it is less than 35 (CPX #$23). If so, it is placed in IBTRK. Otherwise a syntax

Listing 2

```
1 BFR = 8192: PRINT  CHR$ (4)"BLOAD AMPERRWTS.CODE,A$8000"
5  HOME : PRINT "V.T.O.C. (TRACK 17, SECT. 0)
10  & R(17,0,BFR)
15  GOSUB 300
20  FOR J = 1 TO 15
25  HOME : PRINT "CATALOG SECTOR ";J;" (TRACK 17,SECT. ";16 - J;")"
27  & R( PEEK (BFR + 1), PEEK (BFR + 2),BFR)
30  GOSUB 300
40  NEXT
50  END
300  FOR I = 1 TO 500: NEXT
305  & X(BFR,BFR + 191)
310  GET A$
320  HOME
330  & X(BFR + 192,BFR + 255)
340  GET A$
350  RETURN
```

***Listing 3:* UNDELETE**

```
1  PRINT  CHR$ (4);"BRUN AMPERRWTS.CODE,A$8000"
2  HOME
3 DT = 32: REM SEE FIGURE #3
5  PRINT "DRIVE #? ";: GET D$: PRINT D$
6  IF D$ < "1" OR D$ > "2" THEN  GOTO 5
7 D =  VAL (D$)
8  PRINT
10 BFR = 8192
20  & R(17,0,BFR,D): REM READ VTOC
30 T =  PEEK (BFR + 1):S =  PEEK (BFR + 2)
35  IF T = 0 AND S = 0 THEN  END
40  & R(T,S,BFR,D): REM  READ CATALOG
50  FOR J = 0 TO 210 STEP 35
55 TRK =  PEEK (BFR + 11 + J)
57  IF TRK = 0 THEN  END
60  IF TRK <  > 255 THEN  GOTO 100
70  FOR I = 0 TO 28
80  PRINT  CHR$ ( PEEK (BFR + 14 + J + I));
85  NEXT : REM  (I)
90  PRINT : PRINT "UNDELETE (Y) OR (N)? ";: GET A$: PRINT A$
91  PRINT
92  IF A$ <  > "Y" GOTO 98
94  POKE (BFR + 11 + J), PEEK (BFR + 11 + DT + J)
96  POKE BFR + DT + 11 + J,160
97  & W(T,S,BFR,D): GOTO 100
98  IF A$ <  > "N" THEN  GOTO 90
100  NEXT : REM  (J)
110  GOTO 30
```

error message will be displayed. The next step is to JSR to CHKCOM to verify that a comma separates the T and S expressions. If the comma is not found, a syntax message is displayed. If the comma is found, the expression representing the S parameter is evaluated. This evaluation is done exactly as is the T expression, except a syntax error is displayed and processing ends if the expression results in a value greater than 15. The valid result is placed in IBSECT, the IOB sector parameter.

The next step is to JSR to CHKCOM, looking for a comma between the S and B expressions. The B expression is evaluated first, like the T and S expressions by a JSR to FRMNUM, but since it is a 16-bit value, we must use GETADR to translate the FAC to an integer. This places the result in LINNUM ($50-$51). Once in LINNUM, RWTSCALL moves the buffer address to IBBUFP, the IOB buffer address parameter. The D (drive number) expression is optional. If the routine finds a comma, it evaluates the D expression through a sequence of: 1. JSR CHRGET; 2. JSR FRMNUM; 3. JSR CONINT. If the drive number does not equal 1 or 2, a syntax error message is displayed and processing stops, unless it is stored at IBDRVN (the IOB drive number parameter). If RWTSCALL does not find a comma following the B parameter, then it defaults to a value of 1.

Next we must load the DCT address into IBDCTP (IOB DCT pointer parameter). Now we're ready to JSR to RWTS, which will load the requested sector into the 256-byte area starting at the address pointed to by IBBUFP. If we issued an &R command and wish to see a hex dump of the requested sector, we can issue an X & X command. The format should be & X(B,B + 255); where B is equal to the B parameter in the &R command.

Having &R and &W around allows us to examine and zap any sector on a 16-sector Disk II diskette. One use of these subroutines is given in listing 3, "UNDELETE".

How Undeleting is Possible

Whenever we delete a file from a diskette, the system replaces the track number of the first track/sector list (TRK in figure 1 and listing 3) with $FF (255). Then it places the track number in byte $1E (30) of the name filed in the file's directory entry (DT in figure 1 and listing 3). Track 17 sector 0 (VTOC) contains the track and sector number of the first directory entry in byte offsets 1 and 2 respectively. The directories also have a link to the next

MICRO™

Software Catalog

Name: **Darkstar**
System: Sinclair ZX81, Apple II
Memory: 16K - ZX81
48K RAM - Apple with DOS 3.3
Language: BASIC
Description: Solves darkroom problems relating to print density, magnification, lens opening, neutral density, color balance, filter factors, black-and-white paper type, black-and-white paper grade; variable contrast filters; black-and-white film development. Answers fully compensated for reciprocity and enlarger type. For both black-and-white and color darkroom application. Documentation offers many examples of use.
Price: $99.95 - Sinclair ZX81
$129.95 for Apple II
$550.00 for complete Sinclair package
Includes tape or disk and full documentation. Sinclair package also includes 12" black-and-white monitor and tape deck as well as Sinclair ZX81 with 16K RAM.
Author: Bob Nadler
Available:
F/22 Press
P.O. Box 141
Leonia, NJ 07605

Name: **Hardisk Accounting Series**
System: Apple II or Apple III
Memory: 64K, 128K
Language: UCSD Pascal
Hardware: 5-Megabyte hard disk
Description: *The Hardisk Accounting Series* from Great Plains Software is a menu-driven, double-entry accounting system for small business management and accounting. Each module of the *Hardisk Accounting Series* is interactive and includes complete audit trails. The program is written in UCSD Pascal and currently runs on the Apple II and Apple III with a hard disk. Special features include a password security system, flexible formatting for reports, menu-driven file utilities, budget tracking, and a management information system. Documentation includes cross-reference screen displays and step-by-step instructions. With the extensive data entry prompts and error checking, users will find the *Hardisk Accounting Series* totally comprehensive and very easy to operate and understand.
Price: $395.00/module for GL, AR, AP, Payroll
$595.00 for Inventory, Purchase Order Entry, Sales Order Entry, Job Costing.
Available:
Great Plains Software

Name: **OGI Fig-FORTH**
System: Apple II
Memory: 48K
Language: Machine Language and fig-FORTH
Hardware: Disk II
Description: This is an implementation of the FORTH programming language as defined by the Forth Interest Group (Fig). This high-level compiled language runs much faster than BASIC and requires less development and debugging time due to its structure and interaction with the user. This is a complete system including a screen disk containing a line editor, screen editor, assembler, decompiler, utilities, and more.
Price: $40.00
Includes diskette.
Author: Hal Clark
Available:
On-Going Ideas
RD #1, Box 810
Starksboro, VT 05487

Name: **A2-PBI Pinball**
System: Apple II or Apple II Plus
Memory: 48K
Language: Machine
Description: The ultimate arcade simulation program, which recreates the look and sound of a real pinball table down to the finest detail. *Pinball* offers ten user-selectable modes of play, and allows the user to create and save up to 100 custom modes of his/her own design. Forty parameters, each user-adjustable, control the characteristics of the game.
Price: $29.95
Includes 16-page adjustment manual, instruction card, high-score label.
Author: Bruce Artwick
Available:
Sublogic Communications Corporation
713 Edgebrook Drive
Champaign, IL 61820

Name: **Personal PEARL™**
System: CP/M
Memory: 56K
Language: Pascal
Hardware: Z80 or 8080 at present
Description: *Personal PEARL* lets any user create his own custom program library. Designed for non-technical users as well as those with technical expertise. Combines forms generator, report generator, program generator and database manager. May be used with WordStar and SuperCalc.
Price: $295.00
Includes user manual.
Available:
Relational Systems Int'l. Corp.
P.O. Box 13850
Salem, OR 97309

Name: **Firebug**
System: Apple II or Apple II Plus
Memory: 48K
Language: Assembly Language
Hardware: Disk drive
Description: *Firebug* is a video game requiring fast manual response and quick thinking. It has high scoring potential and challenging maze situations from which to escape. *Firebug* includes colorful graphics and sound effects to heighten the player's involvement.
Price: $24.95
Includes disk, catalog, documentation.
Author: Silas Warner
Available:
Local dealers and distributors, nationwide and in Europe, and MUSE Software.

Name: **GRAPHVICS**
System: VIC-20
Memory: 3K or 8K Expander
Language: Assembly Language
Description: Adds 18 commands to VIC BASIC for creating both hi-resolution and multicolor objects on the VIC-20. Provides two screens: normal text screen and the graphics screen. Swap between the two with a function key. Press another function key to save the graphics screen to tape or diskette. All commands are available to BASIC programs.
Price: $25.00 ($30.00 foreign)
Includes manual and sample programs.
Author: Roy C. Wainwright
Available:
Abacus Software
P.O. Box 7211
Grand Rapids, MI 49510
(616) 241-5510

Name: **Atari Version -The Shattered Alliance**
System: Atari 800 (400 if enough memory)
Memory: 40K with BASICs cartridge
Language: BASIC
Hardware: Monitor, one disk drive
Description: Players have the choice of playing any of three battle scenarios on the fantasy world of Osgorth. Or they can simulate battles of ancient armies. There are a variety of units in the fantasy scenarios, including centaurs, elves, unicorns, dwarfs, lizardmen, and many more. Each is rated for strength, speed, and morale. The game moves at a quick pace due to Strategic Simulations' proprietary Rapidfire Movement system. Two-player and solitaire versions are included.
Price: $39.95
Includes diskette, rulebook, and data cards.
Author: John Lyon
Available:
Strategic Simulations Inc.
465 Fairchild Dr.
Suite 108
Mountain View, CA 94043
(415) 964-1353

Software Catalog
(continued)

Name: **Professional Investment System**
System: OS65U
Memory: 48K
Language: BASIC
Hardware: Ohio Scientific C-2 or C-3 Series
Description: This is an information management system for use by professional financial counseling and investment firms. It is fully menu driven and provides a variety of timely reports, as well as complete and up-to-date portfolios. The basic breakdowns of this system are Market Classifications, Stock/Bond Information, Portfolio, Transactions, and System Information.
Price: $1,500.00
Includes program disk and user's manual.
Available:
Electronic Information Systems, Inc.
P.O. Box 5893
Athens, GA 30604
(404) 353-2858

Name: **Labyrinth**
System: Apple II and Apple II Plus
Memory: 48K
Language: Assembly
Description: Beneath the City of Euqubud on the famed river Ippississim lie Prince Julian's mines — a labyrinth of hundreds of miles of tunnels and caves which was once the richest source of diamonds in the world. The mines are closed now. The yield became too meager and the cost too great, or so they said. Many men believe otherwise, and rumors abound of mysterious and terrifying creatures of the dark caverns which chased Prince Julian's company from the mines and now jealously guard their riches. Many courageous adventurers have ventured back into the deep seeking the fortune they believe to be there, but none has returned. They learned too late the terrifying secret of the labyrinth which ensures the doom of even the best prepared explorer: the walls of the mine are in constant motion, exposing entryways and sealing off exits, as its ghastly guardians render useless both map and compass with their evil engineering.
Price: $29.95
Includes software package.
Author: Scott Schram
Available:
Broderbund Software
1938 Fourth Street
San Rafael, CA 94901
(415) 456-6424
or your local computer store

Name: **CASDUP**
System: Atari 400/800
Memory: Less than 2K
Language: Assembly
Hardware: Cassette recorder
Description: This cassette program will duplicate all cassette-based BASIC, data, and machine-language files. If your Atari computer can read a tape, *CASDUP* will copy it.
Price: $20.00
Includes cassette tape with detailed 21-page instruction manual.
Author: Eric Verheiden
Available:
VERVAN Software
10072 Balsa Street
Cucamonga, CA 91730

Name: **Problem Solving in Everyday Math**
System: Apple II or Apple II Plus with Applesoft in ROM
Memory: 48K
Language: BASIC
Hardware: One disk drive, monitor, or TV
Description: This new process-oriented program takes a step-by-step approach to analyzing practical everyday mathematical problems. The diskette subjects are: how to solve problems; solving addition and multiplication problems; solving subtraction and division problems; other problem-solving processes such as reasoning without numbers, estimating solutions, and analyzing multiple-step problems.
Price: $165.00
Includes documentation, supportive material, four disks.
Author: Dr. Florence Taber
Available:
Interpretive Education, Inc.
157 S. Kalamazoo Mall, Suite 250
Kalamazoo, MI 49007

Software Catalog

(continued)

Name: **EDITRIX^{TM} 1.0**
System: Apple II Plus
Memory: 48K
Language: Applesoft in ROM
Hardware: At least one disk drive with DOS 3.3 and one of the following printers: Anadex 9500/9501/9000/9001; Centronics 739/122/350/351; Epson MX-100/MX-80/MX-70; IDS 440G/445G/460G/560G; ITOH 8510; MPI 88G; NEC 8023; Okidata 82A/83A; Silentype
And one of the following parallel interface cards: Apple Standard/Centronics; CCS 7728; Epson APL; Grappler; Mountain CPS; Prometheus PRT-1/Versacard; SSS-AIO; TYMAC

Description: A new screen-oriented text editor featuring advanced text editing with ease of learning and use. To be used with Data Transforms' Graphtrix 1.3 to form the most powerful text editing/graphics screen dump system available.

Price: $75.00
Includes complete readable instructional manual and free updates as required.

Author: Steve Boker

Available:
Data Transforms Inc.
616 Washington St.
Suite 106
Denver, Colorado 80203
(303) 832-1501

Name: **K-DOS**
System: Atari 800
Memory: 24K minimum RAM
Language: Machine
Hardware: Disk

Description: This command-driven *K-DOS*^{TM} is not only a more powerful and convenient DOS for the Atari 800, but it is completely compatible with the Atari 2.0S and other related software. In addition, *K-DOS* supports the Atari 850 handler which allows the use of printers and modems. *K-DOS* features a machine-language monitor which allows examination and alteration of memory in hexadecimal and displays ATASCII representation; interception of the break instruction does not crash the system, but takes the user back into *K-DOS*; new, powerful commands reserve and erase memory and may be executed when the BASIC or assembler cartridge is in control; *K-DOS* allows the user to create his own commands.

Price: $89.95
Includes 40-page handbook, disk, and pocket command summary card.

Author: Marcus Watts

Available:
K-Byte
1705 Austin
P.O. Box 456
Troy, Michigan 48099
(313) 524-9878

Name: **Financial Analysis Package**
System: Apple II or IBM Personal Computer
Memory: Apple II - 48K bytes RAM memory
IBM - 64K
Hardware: Apple II - Disk II disk controller and at least one Disk II disk drive.
IBM - 80-column video monitor, and a printer.

Description: The Execuware *Financial Analysis Package* provides sophisticated analysis for financial executives in determining whether to lease or buy, figuring loan and lease payment schedules, analyzing capital budgeting alternatives and determining depreciation schedules based on the Economic Recovery Act of 1981. The *Financial Analysis Package* is capable of performing nine versatile functions: 1. Loan Amortization Schedule; 2. Lease Amortization Schedule; 3. Depreciation Schedules; 4. Net Present Value Schedule; 5. Present Value of an Amount; 6. Internal Rate of Return; 7. Lease *versus* Buy Analysis; 8. Variable Rate Loan Schedule; and 9. Variable Payment Lease Schedule.

Price: $274.95
Includes easy to follow step-by-step instruction manual and diskette.

Author: Execuware^{TM} Microcomputer Software Division of Aeronca, Inc.

Available:
Apple and IBM Personal Computer dealers

Name: **Korel The Robot**
System: Apple II
Memory: 64K
Language: Pascal

Description: *Korel The Robot* implements a Pascal-like compiler/debugger environment in which to learn and explore structured programming. By programming Korel (in an easy to master language) to avoid walls, escape mazes, etc., he will help you break down learning walls. A course disk is available which contains all the problems and solutions in the book and can be used to help develop a classroom curriculum or as a personal learning tool.

Price: $242.00
Includes book, Korel Simulator, course disks, and user's manual.

Author: Richard E. Pattis

Available:
Cybertronics Int'l. Inc.
999 Mt. Kemble Ave,
Morristown, NJ 07960

Name: **Jellyfish**
System: Apple II or Apple II Plus
Memory: 48K
Language: Machine (Assembly)

Description: Exciting undersea action! You must recover lost nuclear waste cannisters while avoiding schools of mutant jellyfish and octopuses. Can be played by one or two players and features high-resolution graphics.

Price: $29.95
Includes complete instructions

Author: Mike Burek

Available:
Sirius Software

Name: **TCS^{TM} Total Inventory**
System: CP/M-compatible
Memory: 56K CP/M, 51K TPA, BDOS location: CC00
Language: MBASIC, DBOS, Agent, Machine Language

Description: *TCS^{TM} Total Inventory* offers unique features such as the ability to handle multiple locations and departments. Reports can be keyed by department, location, or vendor with emphasis on management-oriented reporting for close control of stock and sales. When invoicing, the system automatically interrogates inventory for stock levels, item description, and pricing. Used as an interface with *TCS^{TM} Total Receivables.*.

Price includes software, manual, documenation, utilities, sample data.

Available:
TCS Software, Inc.
International Dealer Network

Name: **CP/M Fast Disk**
System: Apple II
Memory: 48K
Language: Assembly
Hardware: Legend 64K or 128KDE Card

Description: Add memory to CP/M and use every bit of RAM on the Legend 64K and/or 128KDE card(s). The *CP/M Fast Disk* allows you to read and write to an emulated disk and eliminates the need to wait for motor speed, track search and other time-consuming mechanical delays. As Legend cards are added, up to 512K of memory can be accessed.

Price: $69.95
Includes disk and manual.

Author: E.S. Tobin

Available:
Legend Industries, Ltd.
2220 Scott Lake Rd.
Pontiac, MI 48054
(313) 674-0953

Name: **Easi/Arima**
System: Apple II
Memory: 48K
Language: Applesoft
Hardware: One or more disk drives and a printer

Description: A forecasting package for stock and commodity traders, which automates the approach developed by Box and Jenkins so that no statistical experience is necessary. It is usually able to forecast stock and commodity prices within 2% over a one- to five-day horizon. Reads Compu-Trac databases directly and includes programs to create, correct, print, and transform its own databases. Right- or left-hand software keypads are also part of the package.

Price: $300.00
Includes one year of maintenance and updates.

Author: Eric Weiss, Ph.D.

Available:
The Winchendon Group
P.O. Box 10114
Alexandria, VA 22310

MICRO

MICRObits

Deadline for MICRObits: 20th of second month before publication; i.e., August 20th for October issue. Send typewritten copy (40-word limit) with $25.00 per insertion. (Subscribers: first ad at $10.00.)

6800/6809 Software

Includes compatible single-user, multi-user and network-operating systems, compilers, accounting and word processing packages. Free catalog.

Software Dynamics
2111 W. Crescent, Sta. G
Anaheim, CA 92801

Kids Can Touch

A Child's Guide to the Apple II Plus Computer. A primer for all ages 8 to 88. Adult supervision not required. Forty-eight pages packed with BASIC programming, how computers work, and their history. $4.95 plus $1.00 shipping.

Kids Can Touch
24 Beechwood Road
Summit, NJ 07901

Scientific Calculator

OSI 8K program with easy entry, input work sheet display, totals in hex and dec. Hex and dollar modes selectable. 8K tape $15. Send SASE for data sheet and free utility program listing.

Harry Hawkins
Box 4432
Burton, SC 29902

Dynamite PET/CBM Accessories!

Write-protect switches/indicators for 2040/4040 disk drives. Real world software at low cost. 2114 RAM adapter (replaces obsolete 6550s) and 4K memory expansion for "old" 8K PETs. Hundreds of satisfied customers. Write for *free* catalog!

Optimized Data Systems
Dept. M, Box 595
Placentia, CA 92670

New! The Aerobics Master

Here's a day-by-day diary for exercisers designed by a runner. Tracks progress of a variety of exercise activities. 48K, DOS 3.3 and ROM Applesoft required. Warranteed upon registration. SASE for more information. Introductory price $22.95 - includes shipping.

Free Lance Ink
1806 Wickham
Royal Oak, MI 48073

(Continued on page 117)

Hardware Catalog

Name: **Apple Computer Case**
Description: A carrying and storage case designed for the Apple II and two disk drives, that may remain connected to a monitor and/or printer with the cover closed or removed completely. The case features a foam-padded interior, non-metalic hold-down strap, removable locking cover, no-slip bumpers and sturdy ABS plastic end-cap construction.
Price: $64.00
Includes UPS delivery to 48 states.
Available:
Fiberbilt
601 West 26th St.
New York, NY 10001

Name: **Fully Extended Wirewrap Prototype Board**
System: Apple II
Description: Size: 2.8" × 10.7" 2-layer pc. Capacity: up to 57 16-pin or 12 40-pin sockets or any combination in between. Carefully designed layout for minimum electrical noise, low impedance, and maximum versatility in layout of ICs, capacitors, and other discretes.
Price: $45.00 (CA residents add 6% tax)
Includes extensive wirewrap technique documentation.
Available:
Spectrum Systems
P.O. Box 2262
Santa Barbara, CA 93120

Name: **Apple Crate™**
System: Apple
Description: *Apple Crate* is a lightweight case for the Apple computer and disk drives.
Price: $92.00
Includes computer case with accessory pocket and case for two disk drives.
Available:
ABCOM Corporation
16005 Sherman Way
Suite 105
Van Nuys, CA 91409
or your local computer store

Name: **Micro View**
System: Almost any 8-bit microcomputer
Description: If you program, engineer, test, or repair microprocessor systems, you can debug fast, thoroughly, and with ease using this new invention. Features include: extensive 256-LED display; shows activity in real time; shows address, data, I/O, program flow, and timing information; traces instabilities; gives telescopic and microscopic views; works at full CPU speed; soldered-in CPU OK; easy to learn and easy to use; based on principle of visual pattern recognition; supports most micros; quick setup; rugged; portable; as general purpose as an oscilloscope. Also good for teaching. Lowest cost tool in its class.
Price: $995.00
Includes complete instrument, personality pack, manual, Micro Chart.
Available:
Micro Logic Corp.
P.O. Box 174
100 2nd St., Dept. MC
Hackensack, NJ 07602
(201) 342-6518

Name: **Full-View 80 Display Card**
System: Atari 800
Memory: 32K and up
Language: Letter Perfect (80-Column Version), BASIC, Machine Language
Description: The *Full-View 80* provides 80-column capability for the Atari 800 with upper and lower case characters, while retaining the normal Atari 40-column/graphics mode. Switching is accomplished *via* an on-board soft-switch. The *Full-View 80* fits in slot 3. With the 32K *Memory Plus* in slot 2 the Atari 800 becomes a powerful 80-column, 48K wordprocessor.
Price: $349.00
Includes all features - no extras.
Available:
Bit 3 Computer Corporation
8120 Penn Ave. S. #548
Minneapolis, MN 55431

Name: **APX-800 APPLE-VERTER**
System: Apple II
Description: VHF RF modulator (Ch. 7-10 tunable). Designed to mount inside the Apple II computer. Installs in seconds. Operates above normal computer harmonics. Exhibits unusually high stability. Can be used with other computer systems with power sources between 8 and 24 VDC.
Price: $29.75
Includes direct connect 10' antenna cable.
Available:
ATV Research
13th and Broadway
Dakota City, NE 68731

Name: **Leggs**
Hardware: MX-80 Printer
Description: *Leggs*™ is a new 'stand' for the Epson MX-80 printer allowing the paper to be put underneath it. *Leggs* installs in seconds in existing tapered holes and requires no tools or changes to the printer. Room for three-inches of paper under the printer. Made of clear acrylic plastic — cheaper than any other stand you can buy.
Price: $15.00
Includes set of four legs.
Available:
Argus, Inc.
Box 9777
Baltimore, MD 21204
or your local computer store

Name: **Cool Stack™ Printer Pal™**
System: Apple II
Description: The *Cool Stack-Sentry II* offers the features of locking, cooling, easy tilt action access, and efficient organization and storage for the Apple II computer system, all in one compact unit. The precision all-steel construction is designed for optimum strength and durability. An attractive textured finish is color matched to the Apple II. The *Printer Pal* stores and feeds printer paper from underneath the printer, offering space-saving convenience and efficiency. Different models are available for other printers.
Price: $175.00 Cool Stack-Sentry II complete.
$29.95 Printer Pal-Model P80 complete with paper support brackets.
Available:
FMJ, Inc.
P.O. Box 5281
Torrance, CA 90510
(213) 325-1900

Name: **AI13 Analog Input System**
System: Apple II
Description: The *AI13* is a high-performance, 12-bit Analog-to-Digital Input System including software. The *AI13* gives the Apple the ability to make precision voltage measurements. The hardware is distinguished by the following: 16 separate input channels, 8 software-selectable voltage ranges from ± 5 volts down to 0-100 millivolts, 20 microsecond conversion time, 12-bit (0.024%) resolution.
Price: $550.00
Includes cabling, software diskette, and comprehensive manual.
Available:
Interactive Structures Inc.
146 Montgomery Ave.
Bala Cynwyd, PA 19004

Name: **Starwriter F-10 Wheel Printer**
Description: High-performance Daisy Wheel printer. Uses industry-standard ribbon cartridges. Standard parallel or RS-232-C interfaces and, by jumper selection, ET X/ACT, X-ON/X-OFF protocols provide maximum flexibility and installation ease. Has extensive built-in wordprocessor functions. Low noise. Choice of friction feed or bi-directional tractor feed. Universal power supply. 30.8 lbs.
Price: $1995.00
Available:
Leading Edge Products
225 Turnpike St.
Canton, MA 02021

MICRObits

(Continued from page 115)

TRS-80 Color Computer Game

MUNCH-O is probably the most challenging arcade-type maze game available for the color computer, with two mazes, nine changing color schemes, sound, and at certain levels, a maze with invisible walls. Minimum 4K. Joystick required. $12.95 cassette.

Mike-Ro Products
P.O. Box 21
Lake Orion, MI 48035

TRS-80 Color Computer

Expand your 4K system to 16K for better color graphics. Full instructions/documentation in each kit. Price of kit is $29.95. Compare at $99.00. Allow two to three weeks for delivery. Check/money orders OK. $3.00 postage/handling charge extra.

Dick Williams
Whispering Pines
Lane 2-1
Derry, NH 03038
(603) 432-3634

OSI Super Defender

Super Defender is an all machine-code game just like the arcades. The mountains roll by as your scanner shows what's comming at you. Protect your humanoids from being snatched by the landing crafts. $14.95 for tape or 5¼" disk.

DMP Systems
319 Hampton Blvd.
Rochester, NY 14612

Lessons in Algebra

An easy and fun way to learn the basic elements of high school algebra. Apple computer diskette $29.95. 30-day money-back guarantee if not satisfied.

George Earl
1302 So. General McMullen Dr.
San Antonio, TX 78237

Apple Education

Physics: 11 diskettes, 75 programs — $200. May be ordered separately. *Happy Face* (four word games) — $15; *Dinosaurs* — $15; *Aquarium* — $25; *Christian Education* — $15. Above programs have extensive hi-res graphics. *Peachy Writer* text editor — $24.95; *Grade Reporter* — $19.95. VISA/MC. Free catalog.

Cross Educational Software
Box 1536 M
Ruston, LA 71270
(318) 255-8921

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438 Roslyn Avenue
Akron, OH 44320

6809 Bibliography

48. 80 Microcomputing, Issue No. 27 (March, 1982)

Cook, Douglas R., "Colormon," pg. 212-213.
A monitor for the 6809-based TRS-80 Color Computer.

Wood, James W., "You Light Up My Life," pg. 330.
Teach the physics of light with this program for interference patterns using the TRS-80 Color Computer.

49. CSRA Computer Club Newsletter (March, 1982)

Gresham, Jim, "Color Computer Ramblings," pg. 3.
Miscellaneous information on the TRS-80 Color Computer including some important ROM addresses.

50. Interface Age 7, Issue 4 (April, 1982)

O'Connor, Patrick and Leah, "Game Corner," pg. 22, 149.
Breakout, a game for the 6809-based TRS-80 Color Computer; discussion and listing.

51. MICRO No. 47 (April, 1982)

Capouch, Brian, "Structured Programming in BASIC09," pg. 45-49.
BASIC09 is a programming language available for 6800/6809-based OS-9 operating systems.

Tenny, Ralph, "Extensions to the C-Bug Monitor," pg. 51-55.
Two valuable debugging functions are added to CBUG, a monitor for the 6809-based TRS-80 Color Computer.

Walker, Gregory and Whiteside, Tom, "Multiprecision Addition — A Comparison of 6809 and 6502 Programming," pg. 57-59.
A comparison using 32-bit addition routines to demonstrate several advantages of programming the MC6809 over the 6502.

Puckett, Dale, "FLEX: An Operating System for the 6809," pg. 61-65.
FLEX is a widely supported operating system for 6800- and 6809-based microcomputers. Its history, features and applications are discussed.

Wright, Loren, "PET Vet," pg. 71-72.
A discussion of the SuperPET, a micro based on both the 6809 and 6502 processors.

Staff, "6809 Microprocessor," pg. 121-122.
A reference sheet for the 6809 microprocessor, with pinouts, programming model, indexed/indirect codes, instruction codes, and a table of branched instruction codes.

52. Commodore Magazine 3, No. 1 (February, 1982)

Staff, "Accessing the SuperPET RS-232 Port," pg. 58-59.
Procedure for the 6809/6502-based SuperPET micro.

53. Compute! 3, No. 11 (November, 1981)

Wilkinson, Terry, "SuperPET's Super Software," pg. 28-36.
Discussion of software for the 6809-based SuperPET.

54. Interface Age 6, No. 10 (October, 1981)

Doonan, Dennis, "MC6809 Cookbook," pg. 152.
"How-To" for the 6809.

55. CSRA Computer Club Newsletter (April, 1982)

Gresham, Jim, "Color Computer Ramblings," pg. 1-3.
Miscellaneous information on the 6809-based Color Computer of Radio Shack.

56. Personal Computer World 5, No. 4 (April, 1982)

Kewney, Guy, "16-Bit Battle Takes Shape," pg. 60-61.
Discussion and comparison of various microprocessors including the 6809, 68000, 8088, 8086, etc.

57. BYTE 7, No. 3 (March, 1982)

Barden, William Jr., "Build a Half-Year Clock for the Color Computer," pg. 100-122.
A hardware article for users of the Radio Shack Color Computer based on the 6809.

58. Personal Computer World 5, No. 5 (May, 1982)

Staff, "Hitachi Peach," pg. 104-108.
A detailed description of the 6809-based Hitachi MB-6890 Personal Computer Basic Master Level 3 micro, also now known as the Hitachi Peach.

59. BYTE 7, No. 5 (May, 1982)

Kocher, Christopher P. and Keith, Michael, "Six Personal Computers from Japan," pg. 61-102.
Information is given on several 6809-based micros including the Canon CX-1, the Hitachi MB-6890, and the Fujitsu FM-8 (two 6809 processors).

Barden, William Jr., "Ports of Entry and Soft Breezes for the Color Computer and Model III," pg. 162-198.
A hardware article for the Radio Shack Color Computer including an anemometer and other remote sensing projects.

60. MICRO No. 48 (May, 1982)

Walker, Gregory and Whiteside, Tom, "Memory Moves with the 6502 and 6809," pg. 19-22.
Advantages of the 6809's direct page addressing and 16-bit registers are shown in a comparison of 6502 and 6809 memory moves.

Dial, Wm. R., "6809 Bibliography," pg. 99.
Some 17 references to the literature on the 6809 microprocessor are cited.

61. BYTE 7, No. 4 (April, 1982)

Harrington, John, "A Simple Multiprocessor Implementation," pg. 464-471.
Multiprocessing with 6809-based systems.

Field, Tim, "Easy Entry Program for Radio Shack's Color Computer," pg. 482-487.
A short BASIC program that will help enter machine-language programs for the 6809-based Radio Shack Color Computer.

62. Commodore Magazine (April/May, 1982)

Staff, "Commodore News: SuperPET," pg. 17-18.
Questions and answers related to the 6809-based SuperPET.

Staff, "SuperPET *vs.* IBM," pg. 21-22.
A close-up look at these competing microcomputers.

63. 80 Microcomputing No. 29 (May, 1982)

Commander, Jake, "Spiromania," pg. 88-96.
Use your 6809-based Color Computer to run a graphics program combining a constantly changing angle with a constantly changing radius to form a spirograph.

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Dr. William R. Dial
438 Roslyn Avenue
Akron, OH 44320

6502 Bibliography

1. Atari Computer Enthusiasts (March, 1982)

Anon., "Tape Handling," pg. 9.

Discussion of the protocol for tape handling on the Atari 810 Tape Drive, including mark and space frequencies, 600 baud rate, data files, etc.

2. Microcomputer Printout 3, No. 4 (March, 1982)

Butterfield, Jim, "Disk Doctor," pg. 64-67.

Two useful disk routines for the CBM micros. One is for checking the veracity of a particular disk and the other for changing your drive number with recourse to a soldering iron.

3. MICRO No. 46 (March, 1982)

Neils, Jody, "KIM Bouncy Keypad Cure," pg. 77-80.

A 94-byte program to eliminate the annoying key-bounce and prolong the life of the KIM-1 keypad.

4. Commodore Magazine (February, 1982)

Tomczyk, Michael S., "The VIC Magician," pg. 39-51.

The VIC-20 as a super calculator, a light pen drawing program, and other routines for the VIC.

5. Microcomputing 6, No. 3 (March, 1982)

Multer, Kent A., "Freedom from Text Editor Tyranny," pg. 72-78.

A friendly word processor for the Atari, 'Runoff,' including an interface for the Epson MX-80 printer.

6. RTTY Journal 30, No. 3 (March, 1982)

Hammon, George, "Apple Computers and RTTY," pg. 4-6.

How to put the Apple on an amateur radioteletype, transmitting and receiving at 110 baud ASCII or at 60, 67, 75, or 100 WPM Baudot.

7. RTTY Journal 30, No. 3 (March, 1982)

Johnson, Thomas C., "Oscar Pathfinder," pg. 46-51.

A colorful way to track amateur radio satellites using the Apple, in Applesoft BASIC.

8. Apple Gram 4, No. 3 (March, 1982)

David, Jill, "Using Your Pascal Editor as a Word Processor," pg. 23-30.

The Apple Pascal program RJUSFY may be used with your text files to make your Pascal system work like a word processor.

9. Creative Computing 8, No. 3 (March, 1982)

Lubar, David, "Table Lookup," pg. 160-166.

A 6502 machine-language routine to handle lookup tables, with examples for the Apple.

10. Byte 7, No. 3 (March, 1982)

Starbuck, Bill, "Epson MX-80 Print Control for the Apple," pg. 166-170.

A program to set up your Apple for the various typing modes.

Microcomputer Information Resources

MICRO wants to make sure our readers are aware of the excellent sources of microcomputer bibliographic information that are available. *Microcomputer Index* is a periodical that provides a subject index for a cross-section of popular microcomputer magazines. It includes abstracts. Published by Microcomputer Information Services, 2646 El Camino Real #247, Santa Clara, CA 95051, *Microcomputer Index* has put more than 10,000 articles, indexed and abstracted from 23 periodicals, on line with Lockheed's DIALOG service. Probably the best single source of bibliographic information in book form about articles published in microcomputer magazines is *The Index*. Compiled by W.H. Wallace and published by Missouri Indexing, Inc. (P.O. Box 301, St. Ann, MO 63074), *The Index* is not only comprehensive, but so well organized that using it is a pleasure. Another helpful publication is *Micro ... Publications In Review* (Vogeler Publishing Inc., P.O. Box 489, Arlington Heights, IL 60006). This periodical reproduces the tables of contents of the latest issues of the major microcomputer magazines, and provides a subject index.

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What would you do if you missed out on this offer?

You'd have missed out on a chance to upgrade from Apple Pascal to the software that lets you write applications on your Apple II that will run without recompilation on virtually *any* microcomputer. Period.

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My check is enclosed ☐

Please charge to my Acct. #__________

Visa ☐ Master Charge ☐ Expiration Date______ Name on card__________

I hereby certify that I am an Apple Pascal Owner. My proof of purchase is

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Company__________ **Telephone**__________ **Ext.**______

Address__________ **City**__________ **State**______ **Zip**______

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AARDVARK — THE ADVENTURE PLACE

ADVENTURES FOR OSI, TRS-80, TRS-80 COLOR, SINCLAIR, PET, VIC-20

ADVENTURES — Adventures are a unique form of computer game. They let you spend 30 to 70 hours exploring and conquering a world you have never seen before. There is little or no luck in Adventuring. The rewards are for creative thinking, courage, and wise gambling — not fast reflexes.

In Adventuring, the computer speaks and listens to plain English. No prior knowledge of computers, special controls, or games is required so everyone enjoys them — even people who do not like computers.

Except for Quest, itself unique among Adventure games, Adventures are non-graphic. Adventures are more like a novel than a comic book or arcade game. It is like reading a particular exciting book where you are the main character.

All of the Adventures in this ad are in Basic. They are full featured, fully plotted adventures that will take a minimum of thirty hours (in several sittings) to play.

Adventuring requires 16k on Sinclair, TRS-80, and TRS-80 Color. They require 8k on OSI and 13k on VIC-20. Sinclair requires extended BASIC.

TREK ADVENTURE by Bob Retelle — This one takes place aboard a familiar starship and is a must for trekkies. The problem is a familiar one — The ship is in a "decaying orbit" (the Captain never could learn to park!) and the engines are out (You would think that in all those years, they would have learned to build some that didn't die once a week). Your options are to start the engine, save the ship, get off the ship, or die. Good Luck.

Authors note to players — I wrote this one with a concordance in hand. It is very accurate — and a lot of fun. It was nice to wander around the ship instead of watching it on T.V.

CIRCLE WORLD by Bob Anderson — The Alien culture has built a huge world in the shape of a ring circling their sun. They left behind some strange creatures and a lot of advanced technology. Unfortunately, the world is headed for destruction and it is your job to save it before it plunges into the sun!

Editors note to players — In keeping with the large scale of Circle World, the author wrote a very large adventure. It has a lot of rooms and a lot of objects in them. It is a very convoluted, very complex adventure. One of our largest. Not available on OSI.

HAUNTED HOUSE by Bob Anderson — This one is for the kids. The house has ghosts, goblins, vampires and treasures — and problems designed for the 8 to 13 year old. This is a real adventure and does require some thinking and problem solving — but only for kids.

Authors note to players — This one was fun to write. The vocabulary and characters were designed for younger players and lots of things happen when they give the computer commands. This one teaches logical thought, mapping skills, and creativity while keeping their interest.

DERELICT by Rodger Olsen and Bob Anderson — For Wealth and Glory, you have to ransack a thousand year old space ship. You'll have to learn to speak their language and operate the machinery they left behind. The hardest problem of all is to live through it.

Authors note to players — This adventure is the new winner in the "Toughest Adventure at Aardvark Sweepstakes". Our most difficult problem in writing the adventure was to keep it logical and realistic. There are no irrational traps and sudden senseless deaths in Derelict. This ship was designed to be perfectly safe for its' builders. It just happens to be deadly to alien invaders like you.

NUCLEAR SUB by Bob Retelle — You start at the bottom of the ocean in a wrecked Nuclear Sub. There is literally no way to go but up. Save the ship, raise her, or get out of her before she blows or start WWIII.

Editors note to players — This was actually plotted by Rodger Olsen, Bob Retelle, and someone you don't know — Three of the nastiest minds in adventure writing. It is devious, wicked, and kills you often. The TRS-80 Color version has nice sound and special effects.

EARTHQUAKE by Bob Anderson and Rodger Olsen — A second kids adventure. You are trapped in a shopping center during an earthquake. There is a way out, but you need help. To save yourself, you have to be a hero and save others first.

Authors note to players — This one feels good. Not only is it designed for the younger set (see note on Haunted House), but it also plays nicely. Instead of killing, you have to save lives to win this one. The player must help others first if he/she is to survive — I like that.

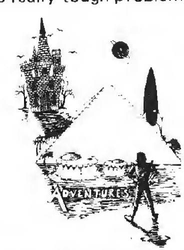
PYRAMID by Rodger Olsen — This is one of our toughest Adventures. Average time through the Pyramid is 50 to 70 hours. The old boys who built this Pyramid did not mean for it to be ransacked by people like you.

Authors note to players — This is a very entertaining and very tough adventure. I left clues everywhere but came up with some ingenous problems. This one has captivated people so much that I get calls daily from as far away as New Zealand and France from bleary eyed people who are stuck in the Pyramid and desperate for more clues.

QUEST by Bob Retelle and Rodger Olsen — THIS IS DIFFERENT FROM ALL THE OTHER GAMES OF ADVENTURE!!!! It is played on a computer generated map of Alesia. You lead a small band of adventurers on a mission to conquer the Citadel of Moorlock. You have to build an army and then arm and feed them by combat, bargaining, exploration of ruins and temples, and outright banditry. The game takes 2 to 5 hours to play and is different each time. The TRS-80 Color version has nice visual effects and sound. Not available on OSI. This is the most popular game we have ever published.

MARS by Rodger Olsen — Your ship crashed on the Red Planet and you have to get home. You will have to explore a Martian city, repair your ship and deal with possibly hostile aliens to get home again.

Authors note to players — This is highly recommended as a first adventure. It is in no way simple — playing time normally runs from 30 to 50 hours — but it is constructed in a more "open" manner to let you try out adventuring and get used to the game before you hit the really tough problems.



ADVENTURE WRITING/DEATHSHIP by Rodger Olsen — This is a data sheet showing how we do it. It is about 14 pages of detailed instructions how to write your own adventures. It contains the entire text of Deathship. Data sheet - $3.95. NOTE: Owners of OSI, TRS-80, TRS-80 Color, and Vic 20 computers can also get Deathship on tape for an additional $5.00.

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- two internal timers
- serial/parallel shift register
- input data latching

— Because of its general purpose design, the 6522 can be used with most microcomputers including the 65XX and 68XX families.

6522 Pinout

Signal	Pin	6522	Pin	Signal
Vss	1		40	CA1
PA0	2		39	CA2
PA1	3		38	RS0
PA2	4		37	RS1
PA3	5		36	RS2
PA4	6		35	RS3
PA5	7		34	RES
PA6	8		33	D0
PA7	9		32	D1
PBO	10	6522	31	D2
PB1	11		30	D3
PB2	12		29	D4
PB3	13		28	D5
PB4	14		27	D6
PB5	15		26	D7
PB6	16		25	2
PB7	17		24	CS1
CB1	18		23	CS2
CB2	19		22	R/W
Vcc	20		21	IRQ

6522 Registers

Register Number		Register Designation	Description: Write	Read
0	$00	ORB/IRB	Output register B	Input register B
1	$01	ORA/IRA	Output register A	Input register A
2	$02	DDRB	Data direction register B	
3	$03	DDRA	Data direction register A	
4	$04	T1C-L	T1 low-order latches	T1 low-order counter
5	$05	T1C-H	T1 high-order counter	
6	$06	T1L-L	T1 low-order latches	
7	$07	T1L-H	T1 high-order latches	
8	$08	T2C-L	T2 low-order latches	T2 low-order latches
9	$09	T2C-H	T2 high-order counter	
10	$0A	SR	Shift register	
11	$0B	ACR	Auxilliary	
12	$0C	PCR	Peripheral control register	
13	$0D	IFR	Interrupt flag register	
14	$0E	IER	Interrupt enable register	
15	$0F	ORA/IRA	Same as register 1, except no handshaking	

6522 (VIA)

Reg 11 ($0B) — Auxiliary Control Register (ACR)

Bits: 7 6 5 4 3 2 1 0

T1 TIMER CONTROL (bits 7, 6)

7	6	OPERATION	PB7
0	0	TIMED INTERRUPT EACH TIME T1 IS LOADED	DISABLED
0	1	CONTINUOUS INTERRUPTS	DISABLED
1	0	TIMED INTERRUPT EACH TIME T1 IS LOADED	ONE SHOT OUTPUT
1	1	CONTINUOUS INTERRUPTS	SQUARE WAVE OUTPUT

T2 TIMER CONTROL (bit 5)

5	OPERATION
0	TIMED INTERRUPT
1	COUNT DOWN WITH PULSES ON PB6

PA (bit 0), PB (bit 1) — LATCH ENABLE/DISABLE

0 = DISABLE
1 = ENABLE LATCHING

SHIFT REGISTER CONTROL (bits 4, 3, 2)

4	3	2	OPERATION
0	0	0	DISABLED
0	0	1	SHIFT IN UNDER CONTROL OF T2
0	1	0	SHIFT IN UNDER CONTROL OF $\Phi 2$
0	1	1	SHIFT IN UNDER CONTROL OF EXT. CLK
1	0	0	SHIFT OUT FREE RUNNING AT T2 RATE
1	0	1	SHIFT OUT UNDER CONTROL OF T2
1	1	0	SHIFT OUT UNDER CONTROL OF $\Phi 2$
1	1	1	SHIFT OUT UNDER CONTROL OF EXT. CLK

Reg 12 ($0C) — Peripheral Control Register (PCR)

Bits: 7 6 5 4 3 2 1 0

CB2 CONTROL (bits 7, 6, 5)

7	6	5	OPERATION
0	0	0	INPUT NEGATIVE ACTIVE EDGE
0	0	1	INDEPENDENT INTERRUPT INPUT NEGATIVE EDGE
0	1	0	INPUT POSITIVE ACTIVE EDGE
0	1	1	INDEPENDENT INTERRUPT INPUT POSITIVE EDGE
1	0	0	HANDSHAKE OUTPUT
1	0	1	PULSE OUTPUT
1	1	0	LOW OUTPUT
1	1	1	HIGH OUTPUT

CB1 INTERRUPT CONTROL (bit 4)

0 = NEGATIVE ACTIVE EDGE
1 = POSITIVE ACTIVE EDGE

CA1 INTERRUPT CONTROL (bit 0)

0 = NEGATIVE ACTIVE EDGE
1 = POSITIVE ACTIVE EDGE

CA2 CONTROL (bits 3, 2, 1)

3	2	1	OPERATION
0	0	0	INPUT NEGATIVE ACTIVE EDGE
0	0	1	INDEPENDENT INTERRUPT INPUT NEGATIVE EDGE
0	1	0	INPUT POSITIVE ACTIVE EDGE
0	1	1	INDEPENDENT INTERRUPT INPUT POSITIVE EDGE
1	0	0	HANDSHAKE OUTPUT
1	0	1	PULSE OUTPUT
1	1	0	LOW OUTPUT
1	1	1	HIGH OUTPUT

Reg 13 ($0D) — Interrupt Flag Register (IFR)

Bits: 7 6 5 4 3 2 1 0

BIT		SET BY	CLEARED BY
0	CA2	CA2 ACTIVE EDGE	READ OR WRITE REG 1 (ORA)
1	CA1	CA1 ACTIVE EDGE	READ OR WRITE REG 1 (ORA)
2	SHIFT REG	COMPLETE 8 SHIFTS	READ OR WRITE SHIFT REG
3	CB2	CB2 ACTIVE EDGE	READ OR WRITE ORB
4	CB1	DB1 ACTIVE EDGE	READ OR WRITE ORB
5	TIMER 2	TIME OUT OF T2	READ T2 LOW OR WRITE T2 HIGH
6	TIMER 1	TIME OUT OF T1	READ T1 LOW OR WRITE T1 HIGH
7	IRQ	ANY ENABLED INTERRUPT	CLEAR ALL INTERRUPTS

Reg 14 ($0E) — Interrupt Enable Register (IER)

Bits: 7 6 5 4 3 2 1 0

- 0 — CA2
- 1 — CA1
- 2 — SHIFT REG
- 3 — CB2
- 4 — CB1
- 5 — TIMER 2
- 6 — TIMER 1
- 7 — SET/CLEAR

0 = INTERRUPT DISABLED
1 = INTERRUPT ENABLED

NOTES:

1. IF BIT 7 IS A "0", THEN EACH "1" IN BITS 0-6 DISABLES THE CORRESPONDING INTERRUPT.
2. IF BIT 7 IS A "1", THEN EACH "1" IN BITS 0-6 ENABLES THE CORRESPONDING INTERRUPT.
3. IF A READ OF THIS REGISTER IS DONE, BIT 7 WILL BE "0" AND ALL OTHER BITS WILL REFLECT THEIR ENABLE/DISABLE STATE.

Programming Example

A simple GETKEY routine — an example of using the VIA's control registers.

```
INIT    LDA   #% 0111 1111
        STA   IER              disable all interrupts
        LDA   PCR
        AND   #% 1111 1110     enable CA1 — negative
                               active edge
        STA   PCR
        LDA   ACR
        ORA   #% 0000 0001     latch on CA1
        STA   ACR
        LDA   #0               set all port A lines
        STA   DDRA             for input
KWAIT   JSR   KGET             loop until key pressed
        BCS   KWAIT            null rejected

KGET    SEC
        LDA   IER
        BIT   # 0000 0010      CA1 set?
        BEQ   RETURN
        LDA   IRA              (register 2, with
                               handshaking)
        CLC
RETURN  RTS
```

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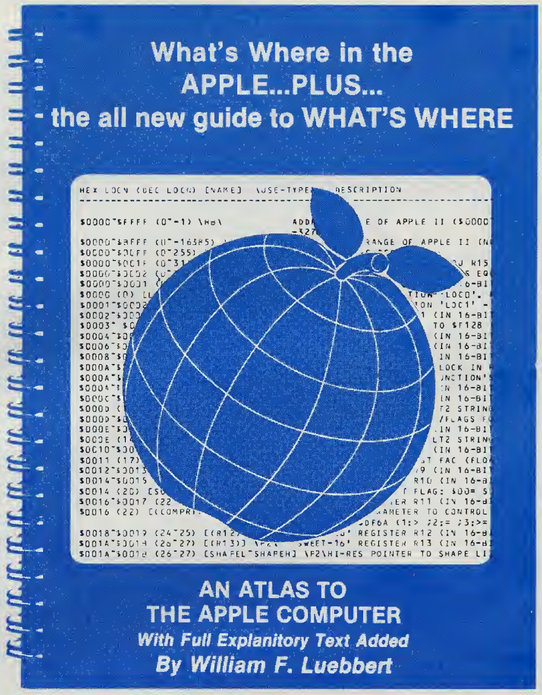

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Next Month in MICRO

September 68000 Feature

- **The 68000's Instruction Set —** The first installment in a series offering detailed descriptions of the 68000's instructions. Part I contains a brief introduction to this chip.
- **An MC68000 Overview —** A discussion by Motorola of the 68000's registers and addressing modes.
- **The 68000 and the Personal Computer —** A look at how owners of 6502-based machines can benefit from the 68000.

Other Highlights

BASIC AIDS

Compress for the Apple
Auto Save for the PET
Amper POS — An Applesoft Position Function
Formatting Output on the Atari

HARDWARE

Delayed Reset on the OSI
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Superimposing TV Pix on the PET

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Softlights

By Fred Huntington

It's an exciting time around the Huntington household this month. We're very proud to announce the birth of our seven-pound five-ounce baby boy, Dale, born on June 6, 1982 in Visalia, California. Baby and Mama are doing just great and Melody (our three-year-old) loves him and calls him "My baby."

The other big news is that I have resigned my position as school principal so that I may devote full time to Huntington Computing.

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Watch next month's Softlights for the winners of the Great Grandma Huntington contest. There were some fantastic entries.

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